Learning environment affordances:
Bridging the gap between potential, perception and practice

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Abstract

Over the past decade, there has been significant investment into new school buildings in Australia. This period of educational facility growth has given rise to the emergence of innovative learning environments (ILEs), spaces which exhibit a wider range of affordances for learning than traditional classrooms.

Whilst ILEs are intended to offer more pedagogical opportunities for teachers and students, little is known about how the affordances of ILEs are being used. This study clarifies the concept of affordances within the context of physical learning environments, identifies how affordances are perceived by architects and teachers, and synthesises a range of strategies to support teachers to take advantage of ILE affordances to enhance deeper learning.

The research is embedded within an Australian Research Council (ARC) Linkage Project called *Innovative Learning Environments and Teacher Change* (ILETC), which investigates how teachers across Australia and New Zealand can be supported to use ILEs to achieve deep learning goals for their students.

This qualitative research project was conducted as two distinct studies. The first study involved investigating teachers' and architects' perceptions of affordances for learning across traditional and ILE spaces in five educational facilities. The second study investigated teachers' understandings and use of affordances in support of pedagogies for deep learning. An innovative methodological pairing of participatory action research (PAR) and co-design was employed to work with teachers from two secondary schools to develop understandings of the processes by which new learning spaces can be actioned for deep learning. Data were collected through workshops, semi-structured interviews and teacher reflections.

Findings show differences in the perceptions of teachers and architects with respect to learning environment affordances, with teachers found to perceive more affordances for learning than architects. A taxonomy of affordances for varied teaching and learning approaches was also identified. Furthermore, strategies were developed to support teachers to take advantage of the affordances of ILEs. These strategies related to connections between infrastructure, school organisation and teacher practice.

Declaration

I declare that this thesis comprises my original work towards the Doctor of Philosophy degree except where indicated in the front matter or acknowledged in the text. The thesis is fewer than 100,000 words, exclusive of tables, figures, and references. The research was conducted with the approval of the University of Melbourne's Human Research Ethics Committee (HREC Project ID:1749828).

Fiona Young

Preface

Throughout my doctoral study I have presented at conferences and prepared papers for publication relating to this research project. Some of these presentations and publications were collaborative. Portions of chapter two, four and six contain material that has been included in these publications. These are noted as follows:

Published journal article

Young, F., Cleveland, B. & Imms, W. (2020). The affordances of innovative learning environments for deep learning: Educators' and architects' perceptions. *Aust. Educ. Res.* 47, 693–720. https://doi.org/10.1007/s13384-019-00354-y

This paper formed a portion of Chapter 4.

Accepted for publication, forthcoming journal article

Young, F., Tuckwell, D. & Cleveland, B. (forthcoming). Actualising the affordances of innovative learning environments through co-creating practice change with teachers.

This paper has been accepted by Australian Educational Researcher. It formed a portion of Chapter 6.

Journal article under review

Young, F. & Cleveland, B. (unpublished). Affordances, architecture and the action possibilities of learning environments: A critical review of the literature and future directions.

This paper formed a portion of Chapter 2.

Conference presentations

Young, F. & Imms, W. (2020). Designing 'innovative' learning spaces that positively impact teaching and student learning. Invited presentation at *The 5th International Symposium on Planning and Design of Contemporary K-12 Education Buildings*, Shenzhen, China.

Young, F. & Leonard, R. (2020). Affordances: Synchronising pedagogy with space. Invited presentation at *EduTECH 2020 Virtual*, Australia.

Young, F. (2019). Does space make a difference? Invited presentation at *The great debate: Learning spaces and architecture*, NSW ACT Independent Education Union, Sydney, Australia.

Young, F. (2019). The affordances of innovative learning environments. Invited presentation at the *Designing Learning symposium*, Museum of Applied Arts and Sciences (MAAS), Sydney, Australia.

Young, F. (2019). Affordances, objects and learning environments. Keynote at *Teachers Big Day Out*, University of Adelaide, Adelaide, Australia.

Young, F., Cleveland, B. & Imms, W. (2018). Affordances of innovative learning environments (ILEs): A participatory action research process to engage educators in developing and utilising tools to support transition to ILEs. Paper presented at *Australian Association for Research in Education (AARE)*, Sydney, Australia.

Young, F. & Krysiak, N. (2018). Designing for serious play: Why play is key to resilience and (re)imagined learning spaces. Presented at *Learningscapes*, Association for Learning Environments, Chicago, USA.

Young, F. & Leonard, R. (2018). Hacking the classroom: Using prototyping to (re)imagine new learning environments. Presented at *Learningscapes*, Association for Learning Environments, Chicago, USA.

Young, F. & Leonard, R. (2018). Collaborating to repurpose and redesign learner-centric spaces. Invited presentation at *Connecting Innovative Learning Spaces and Pedagogy* conference, Criterion, Melbourne, Australia.

Young, F. & Imms, W. (2017). Who is really in charge of designing innovative learning environments? Keynote at *Learning Environments Australasia Regional Day Out*, Brisbane, Australia.

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When I finished architecture school, doing a PhD was not on my radar. Through a winding and unanticipated journey of professional roles, experiences, encounters and countries I find myself at the other end of one. And whilst often gruelling, I realise that it has been an absolute privilege to have experienced this level of intellectual application in an area which I am passionate about.

I am very grateful to the many people who have been part of this PhD journey with me and who have encouraged, steered and supported me on this path. I would like to acknowledge the support of the Australian Research Council and industry partners who funded the *Innovative Learning Environments and Teacher Change (ILETC)* project which my research is part of. I certainly wouldn't have been able to undertake this research without the knowledge and support of the ILETC team. Thank you to the ILETC Chief Investigators for creating and steering such an amazing project and for including me — it has been an incredible culture to be part of. Thank you to Marian Mahat, Joann Cattlin, Sarah Healy and Chris Bradbeer for many hours of timely advice and moral support. And to my fellow PhDs — Ethel Villafranca, Vicky Leighton, Raechel French, Anne Knock, Dion Tuckwell, Mark Osborne and Dan Murphy — thank you for the thought-provoking discussions and fantastic camaraderie developed in the past 4.5 years. Dion Tuckwell, I have loved being part of your crazy 'makerly' world. Thank you for bringing the joy of 'play' into research.

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I am profoundly grateful to my Hayball colleagues for their ongoing support and patience. There are way too many Hayballers to mention separately, however I'd like to specifically thank the Directors for enabling my research-practice nexus. In particular, thank you to Richard Leonard for your ongoing support, feedback and mentorship which is both invaluable and always inspiring. To David Tordoff for your consideration and patience around the day job and to Natalia Krysiak and Dani Martin for the helpful discussions and valuable feedback along the way.

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I'd like to thank my mother, Pam Young, for regularly journeying across to Sydney from New Zealand over the years to help look after the family and enable me the time to focus on my research. I know that all the things my brothers and I have done are things that you and Dad could have achieved too, and more, if you had had the same opportunities that your hard work has allowed us to have. Thank you for paving the way for us.

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Definition of Terms for the Purposes of this Study

Co-design

Co-design is a research approach which applies ‘designerly’ modes of inquiry as participants make and ‘show’ their voice through a material heuristic (Sanders et al., 2012).

Innovative learning environments (ILEs)

An innovative learning environment (ILE) can be defined “as the product of innovative design of space and innovative teaching and learning practices. Innovative learning spaces are physical educational facilities designed and built to facilitate the widest array of flexibility in teaching, learning, and social educational activity while innovative teaching and learning practices are the sum of teaching and learning activities that in combination assist in the best possible learning outcomes and learning skills of students” (Mahat et al., 2018, p. 20).

Learning Environment Affordance

Learning environment affordances are qualities of the environment (space, objects and people) which enable perceived teaching and learning activities and behaviours (Young, Cleveland, and Imms, 2019, p. 697).

Participatory action research (PAR)

A research approach which aims to change social practices through collective inquiry, experimentation and reflection (Kemmis et al., 2014).

Pedagogy

Pedagogy is the process through which knowledge is produced. It addresses “the 'how' questions, involved not only in the transmission or reproduction of knowledge but also in its production” (Lusted, 1986, p. 2-3). Murphy (2008) extends the definition of pedagogy as “interactions between teachers, students, and the learning environment and the learning tasks” (p. 35).

Strategy

A ‘strategy’ is defined as an explicit concept, theory or practice that enhances teachers’ use of innovative learning environments (Mahat, Bradbeer, Cattlin, et al., 2018, p. 14).

Student deep learning

Student deep learning is characterised by “critically applying new facts to existing knowledge, searching for (as opposed to accepting) meaning, being actively curious about new knowledge, and accepting that learning is a part of their personal development” (Mahat et al., 2018, p. 40).

21st century skills

Skills students need to develop for an increasingly complex world with a focus on the 4C’s (creativity, critical thinking, communication and collaboration) (Mahat, Bradbeer, Cattlin, et al., 2018).

Teacher collaboration

Teacher collaboration (within ILEs) is the spatialised intersection of teaching together, working together, and being together, characterised by a set of practices that jointly leverage opportunities engendered by new spaces, contemporary pedagogies, and teams of teachers, to best meet the needs of all learners (Bradbeer, 2020).

Teacher mind frame

Teacher mind frames can be defined as the ways in which teachers consciously think about their teaching roles, the content and pedagogical knowledge, which in turn has an impact on their attitudes, actions and decisions that are likely to have significant impacts on student learning (Mahat et al., 2018, p. 33). Teachers who exhibit these teacher mind frames are “more likely to have major impacts on student learning” (Hattie, 2017, p. 182).

Teacher spatial competency

Teacher Spatial Competency is a teaching skill embedded within a teacher’s professional practice. It manifests as behaviours that are determined by a transaction that occurs between: an individual’s situated presence in a teaching space; the sensory materiality of the space; the individual’s perceived assessment of the spaces’ usefulness to their teaching goal based on

their experiences; and the teacher's determination of the environment and its affordances potential contribution (in real time) in order to activate it for teaching (Leighton, 2020).

Tools

A 'tool' is "an identifiable activity or protocol, that implements a strategy" (Mahat, Bradbeer, Cattlin, et al., 2018, p. 14).

Chapter 1. Introduction

Reflections on a career in education design

I have practiced as an architect and an exhibition designer for over 20 years. Since 2006 my focus has been on the design of educational spaces at primary, secondary and tertiary levels. During the course of this PhD project I have been employed as an architect at Hayball[1], a practice with a strong pedigree in school design.

It has been an interesting time to be involved in educational design as the types of spaces I have worked on have changed significantly from the types of learning environments I experienced at school. Reflecting on my schooling experiences, the few memories I have of the environments I inhabited with my classmates involve sitting at desks and listening to teachers located at the blackboard at the front of the room. A recent image taken of a classroom at my old high school in New Zealand shows that little has changed since I attended in the 1980's (refer Figure 1).

Figure 1

Recent image of a classroom at my high school in Dunedin, New Zealand

Note: Photo taken by Richard Mitchell, 2020.

[1] Hayball architects have been a partner on four University of Melbourne Learning Environments Applied Research Network (LEaRN) Australian Council Linkage (ARC) grants including the Innovative Learning Environments and Teacher Change (ILETC) project which this PhD project is embedded within: https://www.hayball.com.au

In my work I have the opportunity to gain insights into many different schools and their communities. Typically, my role within projects involves working with schools and their stakeholders to develop their vision for new learning environments. Together with the client I help translate aspirations and understandings of spatial requirements into a brief which becomes foundational to subsequent phases of design and documentation. My role also involves supporting architects to understand how learning environments could be used by teachers and students, and helping educators recognise how aspects of the design might enable effective teaching and learning practices. In essence, my role as an education architect is to translate between the professions of teaching and architecture.

Although every school and every project is different, I have observed some similarities with respect to the design process. School administrators, facilities managers, teachers and parents all have beliefs and perceptions about the intersection of education and contemporary learning spaces. At one end of the spectrum, people embrace the notion that innovative learning environments (ILEs) better support pedagogies associated with project-based, interdisciplinary and collaborative learning. At the other end, there can be fear of deviating from traditional classroom designs and instructional models.

As an architect, it can be difficult to support a school to develop new learning spaces when there is resistance to change from teachers and little definitive evidence about the potential benefits of ILEs to draw upon. Even with an established background in the field, that encompasses a broad knowledge-base of innovative school designs and approaches to new learning spaces from around the world, my lack of experience of teaching has sometimes made it challenging when discussing spaces that are intended to support new pedagogical practices, particularly when there is resistance from an audience of educators.

Reflecting on experiences from my career, some key moments associated with the processes of designing and inhabiting new school buildings have raised my curiosity about links between design and use and between designers and users. I have captured these moments as a series of vignettes, which I use throughout this dissertation to introduce key concepts central to my PhD and to help position the study in the literature about learning space design and use.

Background to the study

Learning space design

Vignette 1 – Evidence for change

A number of years ago I was part of a team charged with the design of a new 'future focussed' school. My role was to work with the educational consultants to help the clients consider how the aspiration to be future focussed might be achieved through the spatial context. The process involved a series of Project Control Group meetings with senior leaders in education and facilities to report on design progress. In one of the most memorable meetings, I shared a design strategy showing alternative options for how a school could be structured. This evoked an outburst from an educational leader, who panned the ideas exclaiming "JOHN HATTIE SAYS THERE'S NO EVIDENCE THAT SPACE MAKES A DIFFERENCE TO LEARNING!". Whilst I felt certain that space must have an influence on how students learn, at the time, this incident made me realise that I was unaware of any empirical research that supported the types of spatial initiatives being suggested.

For over the past decade there has been significant investment into new school buildings throughout Australia. The initial catalyst for this investment was the global financial crisis and the introduction of the Federal Government's $16.2 billion *Building the Education Revolution* (BER) initiative in 2008-9 (Australian Government Department of Education, 2010). More recently, pressing school shortages have led to further significant investment to accommodate the booming population growth in Australian cities. Demographic data from the Grattan Institute estimates that the Australian school student population will increase by 17% between 2016 and 2026, requiring between 400-750 new schools across the country (Goss, 2016, January 22). In the state of New South Wales alone $6 billion has been allocated by School Infrastructure NSW (SINSW) for the four-year period from June 2018 to deliver more than 170 new and upgraded schools (NSW Government, 2018). Whilst this represents the largest point in time investment in schools in NSW history, the need for new schools is on par with other Australian states, including Victoria and Queensland.

The urgency of demographic need in tandem with a scarcity of greenfield sites has required new ways of thinking about the design of schools. Larger schools are being built and many existing schools are being adapted to enable increased enrolments (Bonyhady et al.,

2019). A number of new schools are being built as 'vertical schools' ranging from 4 to 17 stories high and catering for populations of up to 2000 students (Newton, 2019). Deviating from more traditional schools, many of the new developments are taking into consideration opportunities to share spaces with community to maximise the efficient use of new facilities (Newton, 2019).

In this context, learning spaces are increasingly being developed as innovative learning environments (ILEs) (OECD, 2013). Also known as new generation learning environments (NGLEs) (Imms, 2016a) and Modern Learning Environments (MLEs) (Osborne, 2013), the term innovative learning environments (ILEs) (OECD, 2013) has become generally adopted across the globe. These spaces are typically larger than traditional 'cells and bells' classrooms, more open and comprising a range of interconnected spaces that enable the distribution of more diverse learning settings (Cleveland, 2011). Early ILEs in Australia include the facilities at the Australian School of Maths and Science in South Australia (Oliver & Fisher, 2015) and Wooranna Park Primary School in Victoria (Frith, 2015).

ILEs are designed to support more student-centred (rather than teacher-centred) approaches to learning (Dovey & Fisher, 2014) and facilitate a variety of collaborative, participatory, and independent teaching and learning approaches (Imms, 2016b). These pedagogies are commonly aligned with 21st century learning and the development of core competencies, including communication, collaboration, critical thinking, creativity, character education, citizenship and problem solving (Fullan & Langworthy, 2013). Fullan and Langworthy (2013) align these skills with deep learning, an established concept in education discourse and research literature (Biggs, 1970, 1978, 1979; Fullan & Langworthy, 2013; Fullan et al., 2018). Deep learning skills have been identified as critical to thriving in a modern and rapidly changing world (Fullan et al., 2018). The discourse about deep learning and related educational objectives is discussed in Chapter 2.

ILEs may best be thought of as spatio-pedagogical environments defined by the relationship between spaces and the educational activities which take place within them. Rather than being solely about spatial characteristics or design, they result from the relationship between innovative environments and innovative teaching and learning practices (Mahat, Bradbeer, Byers, et al., 2018). This interrelated nature, between space and practice, can extend designers and users conventional understandings about school contexts. This can be challenging for architects charged with the design of new and innovative learning spaces, as whilst they may see examples of how precedents of ILEs *look*, without an understanding

of the teaching and learning practices and activities anticipated to occur it can be difficult to know how these might *work*.

In seeking guidance and feedback on learning space design, there is little research to draw upon to understand how ILEs are currently being used (Blackmore et al., 2011; French et al., 2019). Hattie's (2009) synthesis of over 800 meta-analyses of educational research relating to achievement suggesting that open spaces makes little difference to student learning outcomes. However, Imms (2016a) notes that what may not be apparent from this finding is a lack of consistency in the quality of studies from the original meta-analyses, poor clarity around definitions of 'open versus traditional' spaces and the age of the research used in the studies. The original meta-analyses were based on studies conducted between 1980-1982 and it is questionable that these can be directly translated to the types of practices taking place in ILEs 40 years later.

Vignette 2 – An effective design process

In wanting to expedite the design process and reduce the time and budget required for user group engagement, a school Facility Manager suggested to me "you already know what to do, you don't need to workshop with teachers". At the time, I had a strong sense that involving teachers in the design process was mutually beneficial for both architects and educators (particularly in relation to drawing out the unique context of each school) but I wasn't aware of evidence to convince the Facility Manager otherwise.

Since then, I've noted that some architects don't consider user engagement a key part of design. This was highlighted in a conversation with an architect colleague who noted "I'm looking forward to when the user group stuff is over so we can get into real design"[2].

Historically, architects have commonly been provided a brief by the client that outlines the technical requirements for a project (Blyth & Worthington, 2010). In keeping with this legacy, a Practice Note[3] in 2001 on indicative fee allocations for design stages from

[2] Quote from a presentation delivered at UTS u.lab Mash+Up Forum #6 in August 2012. The transcript from this talk is captured in the publication 'crowd-share innovation: intensive creative collaborations', Schweitzer & Jakovich, 2012, p. 85

[3] Although the 2001 Practice Note is now withdrawn, there is now guidance from the Australian Institute of Architects (AIA) on how an architect might prepare a brief (Australian Institute of Architects (2017). *Brief – contents.* https://acumen.architecture.com.au/project/brief/brief---contents/. However, there is little guidance on appropriate fees for briefing.

the Royal Australian Institute of Architects (RAIA) suggested that 1% or less of an overall architect's fee should be devoted to briefing (Young, 2018). However, this was merely for evaluating and commenting on a client's brief, rather than anything more significant such as detailed user engagement.

In relation to traditional school design, user engagement may seem unnecessary given long-held understandings of what an industrial model of education looks like and what types of spaces support this (Burke & Grosvenor, 2008). A school brief would most likely comprise a series of cellular classrooms, each with a teacher's desk at the front and tables and chairs for students. With expectations about the needs of teaching and learning relatively consistent, designers were able to easily replicate the traditional classroom model without significant need for interpretation. The primary focus of architectural design was therefore on how these classrooms 'fit together' and how they look, rather than how they might accommodate pedagogies to optimise learning. With traditionally defined architectural processes and common expectations around education, there was little scope or apparent need for architects to explore the connections between pedagogy and space. Nevertheless, some prominent architects have lamented the limited role architects played in creating environments to enable better learning, including Hertzberger (2008) who stated:

> Architecture has unfailingly approached the designing of schools from a less than critical position. All the while, it seems, architects meekly followed their briefs and were mainly concerned with formal aspects of the exterior without busying themselves with spatial opportunities that might lead to better education, and with the role they themselves might fulfil there *(Hertzberger, 2008, p. 11)*.

Now that there is more awareness of the value of a wider range of pedagogies to support the development of 21st century skills, there is a greater need for architects to consider how spaces might support learning. This can be challenging for designers who are not trained in teaching or learning and highlights a need for architects to engage further with school users to better understand how to support educational outcomes. However, this approach can be hindered by outdated understandings of architectural design processes and a lack of appreciation of the value more collaborative design approaches can bring.

Findings from a number of studies indicate the benefits of collaborating with teachers and students in the process of school design (Blackmore et al., 2011; Cleveland & Woodman, 2009; Kuuskorpi & González, 2011; Passon et al., 2008; Woolner, Clark, et al., 2012; Woolner, McCarter, et al., 2012). Whilst outcomes from these studies range from better

teacher and student engagement (Woolner, Clark, et al., 2012), to improved academic outcomes within new spaces (Passon et al., 2008), studies on optimal design processes to enable the success of ILEs are limited.

Vignette 3 – Form vs function: Part 1

I have often shared exemplars of innovative school spaces or practices with clients and user groups. I learnt about many of these first-hand from visits to schools and other spaces and in speaking with users about how they work. I share these stories with other groups with the intent of helping them think beyond what they might already know, hoping to open their minds to what might be possible. However, whilst preparing for some workshops and presentations I've been asked by project architects not to use particular images as they fear that workshop attendees may want the aesthetic being depicted. Alternative more 'aesthetically pleasing' images are often preferred which do not capture the concept as well.

These incidents have been curious, as whilst the selected images have never been 'ugly', I've always found educators being more engaged with the concepts being discussed than the aesthetics. It's made me reflect as to whether architects' visual acuity makes them more sensitive/precious/paranoid as to how others might perceive the same things.

Vignette 4 – Form vs function: Part 2

It would appear from many architectural images that architects like minimalism and simplicity in design. Yet, I wonder if this approach should be applied to school design? Or if it is, whether or how this contributes to the educational experience? The 'moments' below reveal the tension in marrying aesthetics and function and have made me query how to achieve both.

In conveying her experience of the design of her new school, a school principal described an interaction with the architect over the detailed design of a large step which could be used for students to sit on or use as a working surface. The principal noted that power outlets were required on the front face of the step. However, the architect was reluctant to position them there and suggested more discreet locations which were not as accessible. The principal noted that she needed to strongly assert herself several times in order to get the power outlets located in a useful location.

More recently, at a workshop I attended about design process, a principal commented that he felt "architects select furniture from their favourite suppliers" regardless of how this "might not work out for us". He felt that architects were driven by an aesthetic prerogative rather than the functional needs of users.

A few studies reveal differences in the perceptions between architects and users (Julean, 2016; Shemesh et al., 2015; Sporrel et al., 2017). They reveal a gap between how experts and non-experts view the physical environment and indicate a need for designers to learn more about user contexts to improve their ability to cater for them. Koutamanis (2006) notes that as architects perceive through an aesthetic lens, their design priorities may commonly differ from those of their clients, leading to environments that might have design limitations for users.

In the context of schools, Noriega et al. (2013) are critical of traditional design processes which they describe as "obscure, personal, non-collaborative, hierarchical and elitist" (p. 143). They believe that designers' aesthetical values can clash with learning values and suggest that bridging the divide between designers and users requires more mutuality and collegiality in the design process and a need to "control your designer's ego" (p. 143). In recognising the transformation of learning agendas over the past few decades, Noriega et al. (2013) suggest that designers need to learn about learning in order for architectural decision-making to address the functional needs of users, rather than the aesthetic prerogative of architects.

Learning space use

Vignette 5 – Innovative space ≠ innovative practice

A number of years ago I worked on a regional tertiary-level science teaching and learning building. Early in the design process I led science staff members on a tour of innovative science teaching facilities in Brisbane, where they were able to see other spaces and speak to the people who used them. As a result of the tour, this group recognised that their original ideas for the new building did not reflect the needs of contemporary students and that there needed to be more of a relationship between formal labs and informal learning spaces. They also realised that for the main informal space (which linked all labs) to work, new procedures needed to be developed for preparing the labs each day. The briefing process was extensive and took place across many workshops with a range of staff and students, beginning from concept right through to developed design phases. When the building was completed, it was recognised with an architectural award.

I had only ever seen the end product through photographs as my role on the project ended after developed design. However, several years after the building was completed, I had the opportunity to visit. As I was led through the building by a staff member I noted that the informal learning space appeared to be used as an equipment storage space. I queried whether this was only being used for storage as it was

currently a university vacation period. To the contrary, it was noted that it didn't work as an informal learning space for safety reasons relating to how the labs needed to be set up, that it was always used for storage, and they didn't know why the architects had designed the spaces like that. This was both shocking and fascinating to me as I realised that so much work had gone into designing the spaces with a range of faculty staff members, however the thinking had not filtered through to the lab technicians. I wondered what needed to have happened for this space to work as originally intended.

With the emergence of innovative learning spaces, there was a belief that new spaces would naturally effect teaching and learning practices (Joint Information Systems Committee (JISC) Development Group, 2006; Oblinger, 2006). However, this has not been the case, with researchers finding that new learning spaces are equally acting as containers for conventional teaching practices as much as they are supporting innovative uses (Halpin, 2007; Mulcahy et al., 2015). Although the greater spatial diversity of ILEs have the potential to support more diverse pedagogical approaches, new spaces alone are not a catalyst for new teaching practices (Blackmore et al., 2011; Halpin, 2007).

New ILE spaces are often challenging environments for teachers who are accustomed to working within cellular classrooms. Being able to adapt and use ILE spaces requires a level of spatial literacy (Fisher, 2004) not commonly taught to teachers (Leighton, in press; Leighton & Byers, 2020). More often than not, as traditional classrooms are the dominant typology within schools (Imms et al., 2017), the practical experience of teachers is linked to operating in these spaces. As Leighton and Byers (2020) point out, "Teachers are taught how to teach curriculum content and pedagogy; however, they are rarely trained on how to use their classroom space to advance and support their teaching to maximise learning experiences for students" (p. 31).

As Heft (1981) notes, it can be disconcerting for designers to realise that users aren't using spaces as intended. However, as ILEs require the concurrent ability of teachers to use them effectively, any perceived 'failure' of ILEs cannot be attributed to design alone. As Blackmore et al. (2011) note, "unless teachers are prepared and are provided with the necessary professional skills, tools and resources to change their practices, the new built spaces will not move them to innovative pedagogies" (p. 38).

Vignette 6 – Recognising the need for practice change

Being part of the Innovative Learning Environments and Teacher Change (ILETC) project I have become increasingly conscious of the need for schools to be proactive about teacher transition strategies when moving to new ILE spaces. I realised, based on my past practice, that the process of school building projects focussed on the creation of spaces, rather than the practices that might take place within the buildings once built. Often, teachers didn't know what their new learning spaces would be like until buildings were completed.

Hearing a teacher at an event speak about her experience[4] of moving to an exciting new collaborative teaching and learning building resonated with what I had observed when she said "when we moved in the thing that struck us was how unprepared we were for what happened next and how we would do it".

Recognising that moving from traditional spaces into a new ILE without preparation could lead to spaces not being well used, I wanted to arm clients with knowledge of the importance of preparing staff to work in more collaborative teaching and learning spaces. In a recent meeting with a school principal about the process of developing his school's new ILE building, I raised the need to consider teacher practice change in advance of the delivery of new spaces to aid a successful transition. The principal's response that this wasn't necessary as they were already innovative. This made me realise a gap in awareness existed with respect to how difficult it can be for educators to transition from cellular classrooms to ILEs.

In the past, learning space literature has tended to focus on the planning and design of facilities, rather than the practices that take place within them (Boys, 2009; French et al., 2019). French et al. (2019) point out that preparing educators to transition to new learning spaces is often ignored by schools, hindering the emergence of new pedagogies.

The reality is that moving from cellular classrooms to larger, more open and connected spaces requires teachers to adapt to greater flexibility, increased visibility and scrutiny, and less hierarchy (Alterator & Deed, 2013; Deed & Lesko, 2015). Transitioning from more independent practices to collective, interactive and team-oriented approaches to teaching and learning can be difficult, as the nature of practice within conventional spaces is deeply ingrained in teachers memories and experiences (Deed & Lesko, 2015). To better

[4] Talk given by Elizabeth Heggart at NSW ACT Independent Education Union *Great Debate: Learning Spaces and Architecture* (September 2019).

enable this transition requires a need to support teachers to effectively work together in new learning spaces (Blackmore et al., 2011; Brogden, 2007; Cotterell, 1984; Deed & Lesko, 2015; Halpin, 2007). However, there is a gap in the literature around methodologies to help teachers shift their practice to enable innovative pedagogies in new learning spaces (Blackmore et al., 2011). Filling that gap requires a deeper and more nuanced understanding of how the physical context of ILEs can be and is used to enhance innovative teaching and learning practices. An understanding of how teachers have been supported in using them will also help uncover methodologies for shifting teacher practice in the use of new learning spaces. These aspects all reflect gaps in the literature and foreground my research. Discourse relating to the challenges of adapting to ILEs and supporting teachers to use new learning spaces is discussed in Chapter 2.

Affordances

The background to the study reveals gaps in both practice and theory around school design and pedagogical practice within ILEs. It not only reveals how the professional backgrounds of designers and educators influence how they might perceive the same contexts through different lenses, but also the challenges faced by teachers in using new spaces. The theory of affordances (Gibson, 1979) offers a potential bridge for both designers and users to connect these domains of space and practice.

Affordances, a concept originally developed by psychologist James Gibson, refers to the complementarity between environment and user. It has been widely adopted and debated in domains including psychology (Chemero, 2003; Costall, 1995; Gibson & Pick, 2003; Gibson, 1979; Greeno, 1994; Michaels, 2003; Reed, 2012; Rietveld & Kiverstein, 2014; Shaw et al., 1982; Stoffregen, 2000a, 2000b; Turvey, 1992; Warren, 1984), technology (Gaver, 1991; Leonardi, 2013; McGrenere & Ho, 2000; Oliver, 2005; Pea, 1997; Shaw, 2017), Human-computer interaction (Norman, 1988), anthropology (Ingold, 2008) and children's environments (Aziz & Said, 2015; Heft, 1988; Kyttä, 2002, 2004; Little & Sweller, 2015; Withagen & Caljouw, 2017; Wyver & Little, 2018).

Surprisingly, there has been little application of affordances in architecture, nor within learning environments theory or practice. This may relate to the lack of research into how spaces are used in practice. In the context of this study, affordances offers a framework through which to investigate the 'action possibilities' of ILEs. Literature relating to

affordance theory and application to fields of architecture and learning environment design is discussed in Chapter 2.

Problem statement, research aims and questions

Given the extensive investment in, and rapid development of new learning spaces it is critical that we better understand how to align space and pedagogical practice in order for ILEs to successfully achieve our intention of enabling a broader range of pedagogies to support deep learning. Whilst ILE spaces are increasingly being recognised through educational facility design awards (see for example the Learning Environments Australasia[5] and Association for Learning Environments[6] awards), there is little research about *how* ILEs may support better learning.

The experiences outlined above have led me to question how we must think about new ILEs to ensure design and implementation processes are aligned with the expectations of teachers and students. From a design perspective, there is not enough understood about ILEs for a consensus view to be held or to develop amongst those designing them (architects and design consultants) or using them (teachers and students) about what characterises effectively-designed and effectively-used spaces. Furthermore, from a use perspective, more knowledge is required about how to support teachers in actualising (perceiving and using) the affordances of ILEs.

Research has demonstrated that school facilities predominantly comprise traditional learning space typologies (Imms et al., 2017), pedagogical practices are mainly based on teacher instruction (Imms et al., 2017) and educators commonly work in isolation (Bradbeer, 2016). In this context, it may appear unsurprising that shifting practice to spaces designed to afford a wider range of pedagogies can be difficult (Fisher, 2004). As Blackmore et al. (2011) note "unless teachers are prepared and are provided with the necessary professional skills, tools and resources to change their practices, the new built spaces will not move them to innovative pedagogies" (p. 38).

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[5] Learning Environments Australasia awards website (showing award winners and commendations from 2008-2020): https://a4le.org.au/awards/about-the-awards/

[6] Association for Learning Environments LE Solutions and MacConnell awards website (showing award winners and commendations from 2012-2019): https://www.a4le.org/A4LE/Programs/LEsolutions_Planning_and_Design_Awards/Past_Winners/A4LE/Programs_Awards/Awards/LEsolutions_Planning_Design_Awards/Past_Winners.aspx?hkey=c8493465-bd9e-406e-ae2e-965cb2e3cbce

A shift in focus from what action possibilities should be afforded through the designs of new learning spaces, to how teachers' can best take advantage of ILEs in support of deep learning (Fullan & Langworthy, 2013, 2014; Fullan et al., 2018; Mahat, Bradbeer, Byers, et al., 2018) has brought into focus the need to find ways of encouraging teachers to think more critically and creatively about the relationships between pedagogy and space. Gaps in practice and research regarding ways to support teachers to enhance their use of ILE spaces positions this research, including questions about how teachers are actualising the affordances of ILEs and how they can be supported to do so in more expansive and creative ways.

ILEs are being designed to enable a wider range of pedagogies in support of 21st Century skills development in creativity, critical thinking, communication, collaboration and problem-solving. However, studies on the influence of ILEs on students have tended to focus on traditional academic measures of literacy and numeracy, rather than these 21st Century capabilities associated with deep learning (Byers et al., 2018). This represents a gap in the literature about how the built environment could support more interdisciplinary teaching and learning practices, and how teachers can optimise these spatial opportunities. This further positions the research, focusing on how spaces support deep learning, rather than traditional academic measures.

Although a number of papers have explored the qualities of school environments that influence users at a general level, there are few that offer what Hertzberger (2008) refers to as 'precision' in relation to how the physical context can support teaching and learning activities. Hertzberger (2008) argued that there is a role for architects to better understand spatial opportunities relating to better learning. He notes:

> Architecture has unfailingly approached the designing of schools from a less than critical position. All the while, it seems, architects meekly followed their briefs and were mainly concerned with formal aspects of the exterior without busying themselves with spatial opportunities that might lead to better education, and with the role they themselves might fulfil there. (Hertzberger, 2008, p. 11)

It is posited here that introducing an affordance perspective to the field of school design may create a valuable and meaningful bridge between architectural designers and the inhabitants of learning spaces (i.e. teachers and students), towards creating more informed spatio-pedagogical settings for teaching and learning. Whilst there is an abundance of literature on affordances from many fields, affordance theory is less understood in fields of

architecture and learning environments. As a result, there is not a lot of research on affordances within learning environments, and even less in relation to how teachers intersect with the affordances of ILEs.

An exploration of ILEs through the lens of affordances offers the opportunity to understand learning spaces with a higher level of precision in relation to *what* they offer and *how* users can actualise this to enhance teaching and learning activities for deep learning. In addition, it offers a framework for a more wholistic reading of the relationship between space and practice, unlocking deeper understandings of the entanglements of space and practice within a system. Expanding an appreciation of affordances beyond direct relationships between environment and user, to recognising the influence of school cultures and organisation on the relationships between space and practice, may aid teachers and students transition into new spaces.

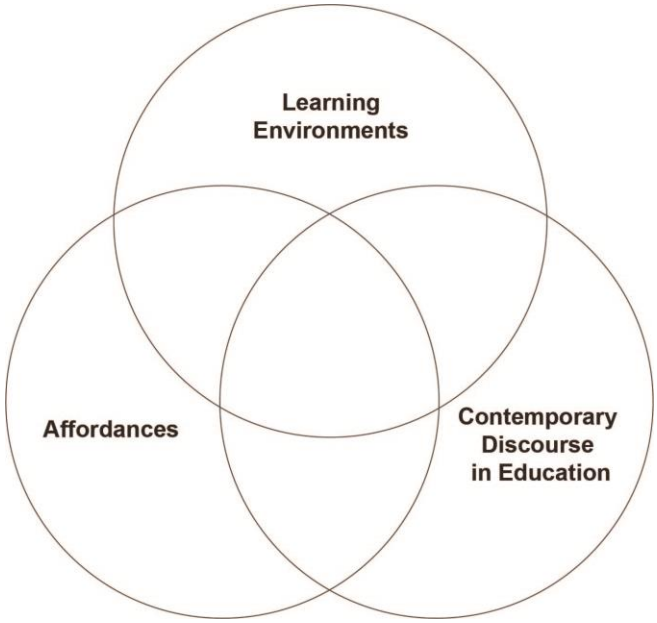
This understanding offers a basis for teachers to enhance their spatial literacy (Fisher, 2004), helping them to perceive new affordances for teaching and learning, appreciate how they are positioned as active participants in educational change, and how their practice may adapt successfully within shifting systems and structures. With this in mind, correlating different perspectives on the relationships between spatial design and the daily practices and activities of teachers and students may begin the critical process of developing a lexicon of affordances (Lindberg & Lyytinen, 2013) that architects and people in schools can call upon to better integrate and intertwine space and action.

This research seeks to understand how the concept of affordances can be applied to school contexts to better align pedagogy and space. More particularly, it seeks to understand the professional perspectives of architects and teachers with respect to the affordances of ILEs, with the goal to support better alignments of practice and environment.

The research also aims to understand how teachers can enhance their spatial literacy to harness the affordances of ILEs for deep learning. This requires an understanding of how teachers are currently actualising the affordances of ILEs. The key concepts for the study are represented in Figure 2. This figure shows the intersecting spheres of learning environments, teachers practice and affordances.

Figure 2

Key concepts for the study



It should be noted that the presence of students, and the influence that they have with each other and with their teachers in the inhabitation of space is a critical aspect of schools. Whilst the student experience is a critical part of the lived experience of schools, the portal for this project is the teacher. This project will primarily centre on teacher's experiences of school spaces. Obtaining direct understandings from students of their experiences of learning spaces was considered outside the scope of this study.

Introduction to research questions

As physical environments are inextricably linked to pedagogy (Dovey & Fisher, 2014; Fisher, 2005; Monahan, 2002), the success of ILEs not only requires shared understandings about what the affordances of ILEs are, but how they can be used, or actualised. The research questions to be explored in this study include:

- What are learning environment affordances? How are they perceived by educators and architects?
- What factors enable teachers to actualise the affordances of learning environments?
- How can teachers be supported to actualise the affordances of ILEs for deep learning?

Justification for the research

This research was embedded within a larger ARC Linkage Project called *Innovative Learning Environments and Teacher Change* (ILETC) (LP150100022). The four-year ILETC project began in June 2016 and has been working in partnership with education departments in New Zealand, Queensland, the ACT and NSW, as well as with industry partners that include furniture designers, ICT and acoustics specialists, school designers and their professional bodies, museums, and leading research-focused schools.

The ILETC project argues that changing the learning environment does not automatically result in improved teaching. In his opening address for the *Terrains 2015: Mapping learning environment evaluation across the design and education landscape international symposium*, John Hattie noted: "If you take teachers out of their egg crates and put them into fascinating and innovative designs, they teach the same way; it makes no difference" (Imms et al., 2015, p. 11). So, why do teachers, arguably, teach the same way despite a change in the learning environment?

The hypothesis of the ILETC project is that unless teachers change their mind frames, or way of thinking about how students can better learn in these spaces, then their teaching practices will remain the same. The main problem that the ILETC project is trying to address is that school teachers, it would seem, are not maximising the potential of ILEs to improve student learning.

In fact, there is little empirical evidence that the built learning environment contributes to improved student learning (Blackmore et al., 2011). Whilst Hattie's (2009) seminal synthesis of over 800 meta-analyses indicated that there was little or no research indicating that space has an influence on students learning outcomes, he noted that one of the biggest intervening factors is the teacher, specifically "what the teachers know, do, and care about" (Hattie, 2003, p. 2). This positioned the focus of the ILETC project on teaching practice as the dependent variable in relationships between learning and space.

The focus of my research is on the physical attributes of ILEs, and the potential action possibilities these offer teachers and students for teaching and learning activities. Through the lens of affordance theory (Gibson, 1977, 1979), my research will explore how physical attributes are understood by designers and school users, and how teachers make use of them to enable pedagogies that support deep learning.

The research investigates; educators' and architects' perceptions in relation to *what* affordances are seen in ILEs in relation to deep learning; *how* teachers perceive the affordances of ILEs and; *how to support teachers* to action the opportunities of these spaces to enhance deep learning.

The primary contribution of this research is in defining affordances in the context of learning environments and developing ways to support educators to actualise the affordances present in their school environments. More broadly, it offers insight into how ILEs are used and how to support teachers to enhance their use.

Significance of the research

This research offers insights into affordance thinking and how it may influence the design and pedagogical use of spaces for deep learning. It explores application of affordance theory in the context of learning environments, which has been broadly explored in other domains but has not been specifically defined or applied deeply in learning environments research. The project addresses gaps in the literature relating to:

- The application of affordance theory in learning environments research.
- The affordances of ILEs for deep learning.
- The inhabitation of ILEs, especially in relation to the intersection of spatial affordances and teacher practice.
- Supporting teachers to actualise affordances within new ILEs.

Introduction to the research approach

To better understand the phenomena of learning environment affordances, this research required an understanding of the meanings that people bring to their contexts (Denzin & Lincoln, 2011). Two separate studies were approached from an interpretivist theoretical perspective. Across these two studies, field research was conducted at case study sites at primary and secondary schools and a museum.

The methodologies employed included a) multiple and embedded single case studies (Yin, 2014) and b) participatory action research (PAR) (Cohen et al., 2007; Kemmis & McTaggart, 2005; Kemmis et al., 2014).

Field data were collected using a variety of social research methods, including semi-structured interviews (Kvale, 1996), auto-photography (Thomas, 2009) and workshops. Data

were analysed using qualitative content analysis (Cho & Lee, 2014; Krippendorff, 2013; Schreier, 2012; Vaismoradi et al., 2014; Weber, 1990; Wilkinson & Birmingham, 2003) and thematic analysis (Braun & Clarke, 2006).

The research approach was iterative in nature, aligning with the wider ILETC project aims and program. Field work was conducted in two distinct phases as follows:

- Study 1: Case studies with architects and educators at five different sites to investigate perceptions of learning environment affordances and initial insights into how teachers have been supported to utilise these.
- Study 2 – Participatory action research with teachers from two different secondary schools to investigate strategies and tools to help teachers develop their understandings of learning environment affordances towards greater actualisation.

The methodology and methods employed for this research are discussed in detail in Chapter 3.

Overview of thesis structure

This thesis is structured in the following way:

Chapter 2 reviews literature on ILEs and the influence of the physical environment on school users. Research gaps are established helping to position the research questions within the field of inquiry. It explores affordance theory from a range of fields and distils relevant interpretations toward clarifying a terminology for affordances in the field of learning environments.

Chapter 3 outlines the theory, methodologies and methods that informed the research design. It discusses the methodologies and provides an overview of methods and data analysis techniques that were employed for the two studies.

Chapter 4 responds to the research question *What are learning environment affordances? How are they perceived by educators and architects?* It presents details of the first phase of fieldwork which investigates architects' and educators' perceptions of the affordances of learning spaces. A description of how the fieldwork was conducted at five case study sites is given. An initial taxonomy of learning environment affordances is presented, as developed through this phase of the project.

Chapter 5 responds to the research question *What factors enable teachers to actualise the affordances of learning environments?* It draws together findings from the first phase of fieldwork to identify a range of strategies that teachers have found beneficial in supporting them to perceive and utilise the affordances of ILEs.

Chapter 6 presents details of the second phase of fieldwork, which involved designing and testing strategies and tools to support teachers to actualise the affordances of ILEs. A description of how the participatory action research process was conducted at the two participating schools is given. This chapter discusses protocols and tools which may be employed to support the use of ILEs and addresses the research question *How can teachers be supported to actualise the affordances of ILEs for deep learning?*

Chapter 7 draws together the findings from the project overall and distils the final conclusions of the research. In drawing these conclusions, the implications of the findings for the design and use of ILEs are discussed. Finally, I reflect on the research process, identifying some limitations of the research and making suggestions for further research.

Chapter 2. Contemporary Educational Practice, School Architecture and Affordances: A Literature Review

Introduction

This chapter sets up the topical and theoretical frameworks that have informed the focus and design of the study. The chapter is structured into three key sections. The first addresses contemporary discourse in educational practice. It discusses 21st Century skills and relationships to deep learning approaches. The second section focuses on school architecture, giving context to the emergence of innovative learning environments (ILEs) and the influence of these spaces on students and teachers. Further, it discusses research relating to teachers' experiences of transitioning into ILEs. The third section, on affordance theory (Gibson, 1979) and its application, comprises three parts: an overview of affordance theory; discussion of the application of affordance theory within the field of architecture; and an exploration into how affordances have been discussed in relation to learning environments.

This chapter provides context to the areas of focus for this study: learning environments, contemporary discourse in education, and affordances. Figure 3 shows a selection of the literature reviewed as part of this study relating to these key areas. A high number of references relate to either learning environments or affordances, with a significantly lower proportion addressing the intersection of the three spheres. Much of the literature on learning environments focusses on ILEs, and the relationship between ILE spaces and school uses and users. Literature that addresses learning environments and affordances is relatively sparse and many items shown refer to multiple papers by a few key authors within the field.

This diagram highlights that whilst affordances are well-recognised in a range of disciplines, such as psychology, technology and human-computer interaction design, there is limited research on affordances within built environments fields, including in learning environments. In positioning this study, key concepts relating to affordance theory are (re)interpreted and defined for a school context. A definition for learning environment affordances is offered in the concluding discussion, based on the literature reviewed. The chapter ends by highlighting gaps in the literature, providing justification for this research project and more specifically the research questions noted in the introduction.

Figure 3

Literature reviewed relating to learning environments, contemporary discourse in educational practice and affordance

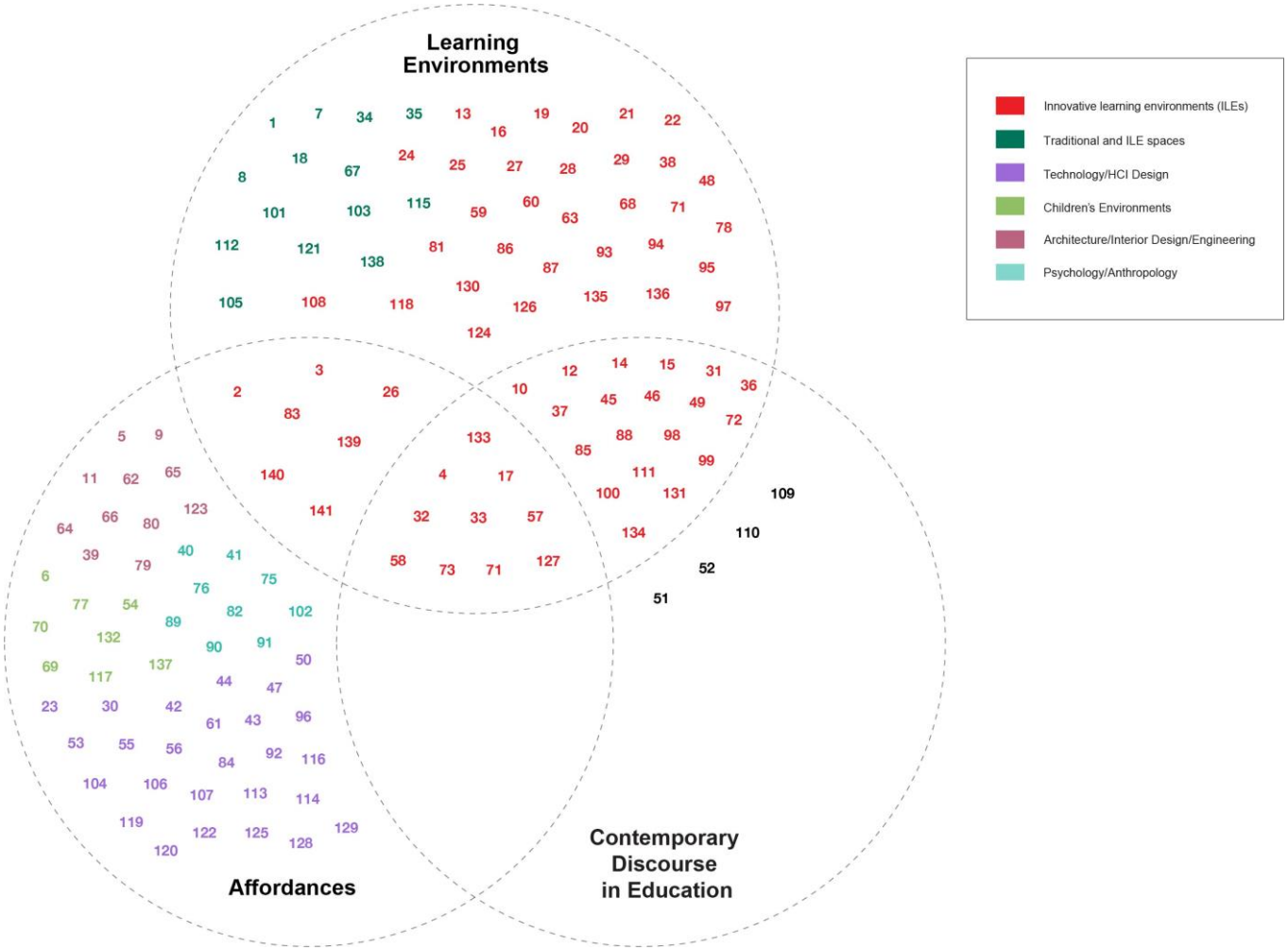


Figure 3

(continued)

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Contemporary discourse in educational practice

21st century skills

Increasing automation and globalisation is changing the nature of work (Foundation for Young Australians, 2017; Frey & Osborne, 2013). From their study of 702 occupations, Frey and Osborne (2013) estimated that 47% of total employment in the United States would be automated within a few decades. Conversely, a 2016 World Economic Forum report noted that "in many industries and countries, the most in-demand occupations or specialties did not exist 10 or even five years ago" (World Economic Forum, 2016, p. 3). These patterns are similarly reported in Australia where it is estimated that over the past 25 years one million jobs have been lost in manufacturing, administration and labouring, whereas more than one million jobs have been gained in knowledge and service industries (Foundation for Young Australians, 2016).

It is predicted that not only will occupations change, but also how people will engage with them. McCrindle Research (2020) estimate that, rather than having a job for life, Australians will make 17 changes in employer across five separate careers. As well, a study undertaken by the Foundation for Young Australians (2015) found that rather than a need for purely technical skills historically sought by employers, there is a growing demand for transferable skills which "enable young people to engage with a complex world and navigate the challenges which they will inherit" (p. 5).

Skills and capabilities required for student success in contemporary society have been described in multiple ways including 'knowledge economy skills', 'soft skills', 'generic skills', 'general capabilities', 'enterprise skills' and '21st century skills' (Department of Education and Training, 2018; Foundation for Young Australians, 2015; OECD, 2012; Regional Australia Institute, 2016). Whilst these identifying terms differ, each reflects the need to support students to develop skills that can be used to undertake non-routine jobs across multiple roles and occupations amidst the increasing automation of routine work (Care et al., 2018; Department of Education and Training, 2018; Frey & Osborne, 2013).

The OECD (2012) describe these 'higher-order' skills as the 4Cs, reflecting aspects of communication, collaboration, critical thinking and creativity. Others also use these core terms, but supplement them in different ways (refer Table 1). For example, the Foundation for Young Australians refer to 'teamwork' rather than collaboration and include problem solving, presentation skills and digital literacy as additional aspects. Whereas in defining

their general capabilities as part of the Australian Curriculum, the Department of Education and Training (2018) describe critical and creative thinking and personal and social capacity, as well as aspects of intercultural understanding, ethical understanding, ICT capability, numeracy and literacy. Fullan and Langworthy (2013) define 6C's, also including character education and citizenship, and describe these as deep learning skills.

Table 1

Various definitions of 21st Century Skills

OECD (2012)	**Fullan and Langworthy (2013)**	**Foundation for Young Australians (2015)**	**Department of Education and Training (Australia) (2018)**
21st Century skills	Deep learning skills	Enterprise skills	General capabilities
Creativity Critical Thinking Communication Collaboration	Creativity and imagination Critical thinking and problem solving Communication Collaboration Character education Citizenship	Creativity Critical thinking Problem solving Communication Teamwork Digital literacy Presentation skills Financial literacy	Critical and creative thinking Personal and social capacity Intercultural understanding Ethical understanding ICT capability Numeracy Literacy

The evolution of work has meant that soft skills have become increasingly valued, often to a higher degree than technical skills. In a study undertaken by the Foundation for Young Australians (2015) which analysed 4.2 million online job postings from between 2012 to 2015, it was found that jobs that demanded critical thinking had increased by 158%, creativity by 65%, presentation skills by 25% and teamwork by 19%. In addition, the premium placed on these key enterprise skills are reflected in higher wages than for roles that don't list these skills. It was also found that jobs of the future, or those least likely to be automated, demanded enterprise skills 70% more frequently than jobs of the past.

Furthermore, across most industries, enterprise skills comprised more than 50% of all the skills required for jobs.

In the United States, Deming (2017) noted that since 1980 there has been growth in employment and salary for roles across a range of professions that required social skills. His study recognised that whilst workers abilities on tasks varied, having social skills enabled people to work in teams to more easily coordinate their work, resulting in greater comparative efficiency and productivity.

Deep learning

Fullan and Langworthy (2013) aligned 21st century skills with deep learning, an established concept in education research literature. 'Surface' and 'deep learning' was first referenced by researchers in the 1970s. Marton and Säljö (1976) aligned surface learning with memorisation, minimum engagement with content, little reflection and a primary focus on passing grades. Similarly, Biggs (1970) associated surface learning with "pass only" aspirations.

In comparison, deep learning has an emphasis on understanding and placing meaning in context (Marton & Säljö, 1976). Deep learning is characterised by "critically applying new facts to existing knowledge, searching for (as opposed to accepting) meaning, being actively curious about new knowledge, and accepting that learning is a part of their personal development" (Mahat, Bradbeer, Byers, et al., 2018, p. 9). The American Institute for Research (AIR) definition of "deeper learning" succinctly combines concepts discussed by various researchers on the topic into three key aspects: 1) a deeper understanding of core academic content; 2) the ability to apply this understanding to new situations; and 3) the development of a range of competencies including people skills (Zeiser et al., 2014).

Biggs' (1970, 1978, 1979) research into students' study approaches helped establish a consistent language around key terms such as 'surface', 'deep' and 'achieving' (Biggs, 1987; Mahat, Bradbeer, Byers, et al., 2018). More recently, Frey et al. (2017) adopted similar terms, where 'surface', 'deep' and 'transfer' referred to the acquisition and consolidation of initial knowledge (surface), interaction with skills and concepts (deep) and organising, synthesising and extending conceptual knowledge (transfer). It is recognised that rather than solely operating on surface or deep learning levels, that students tend to operate on a continuum between the two (Mahat, Bradbeer, Byers, et al., 2018).

Deep learning ‘climates’ are believed to increase students’ sense of purpose, connection to the ‘real world’, and engagement with learning (Fullan et al., 2018). Deeper learning is also thought to build new relationships with and between learners, their family, communities and teachers, and deepen human desire to connect with others to do good—contributing to the development of skills needed to thrive in a modern world (Fullan et al., 2018). Deep learners are those that are empowered to take autonomy over their own learning (Fullan & Langworthy, 2014) and able to engage strongly with creativity, critical thinking, collaboration, and communication skills – the so-called ‘4C’s (Mahat, Bradbeer, Byers, et al., 2018).

Interdisciplinary learning

Interdisciplinary learning involves a situation in which “two or more disciplines are brought together, preferably in such a way that the disciplines interact with one another and have some effect on one another’s perspectives” (Rowntree, 1982, p. 135). It varies from multidisciplinary learning where the same issue might be explored independently as well as through the lens of different disciplines. Interdisciplinary learning juxtaposes and integrates disciplines (Gao et al., 2020; Klaassen, 2018), however individual disciplinary roots remains discernible (Zhang & Shen, 2015). In comparison, a transdisciplinary approach “transcends separate disciplinary perspectives” (Klein, 2008, p. 117), unifying knowledge and skills with the focus on finding novel ways to address problems (Klaassen, 2018; Klein, 2008).

Researchers note that interdisciplinary approaches enable opportunities to engage in higher-order cognitive skills and deep learning (Ackerman & Perkins, 1989; Ivanitskaya et al., 2002; Lake, 1994; Zhang & Shen, 2015). Others have aligned interdisciplinary educational programs with problem solving and enhanced creativity and critical thinking (Deneme & Ada, 2012; Field et al., 1994; Ivanitskaya et al., 2002; Lake, 1994; Zhang & Shen, 2015). Ivanitskaya et al. (2002) note that interdisciplinary approaches to learning can aid students in engaging with the complex problems and perspectives required by modern society.

Recognising the complexity of global and societal issues, and the need to build knowledge and innovation capacity, STEM education has had prominence in recent years (Gao et al., 2020; PricewaterhouseCoopers, 2015). As an umbrella term for the disciplines of Science, Technology, Engineering and Mathematics, interdisciplinary STEM education is aligned with supporting students to acquire skills in problem solving, critical thinking,

collaboration and creativity (Education Council, 2015). Aligned with the need to develop 21st Century skills, the Australian *National STEM School Education Strategy 2016-2026* (Education Council, 2015) notes that STEM literacy is increasingly becoming part of core capabilities needed by Australian employers.

Team teaching

Shaplin and Olds (1964) described team teaching as "a type of instructional organisation, involving teaching personnel and the students assigned to them, in which two or more teachers are given responsibility, working together, for all or a significant part of the instruction of the same group of students" (p. 15). The practice of team teaching emerged after the second world war in the USA in response to a surge in student enrolments and an acute shortage of teachers (Bradbeer, 2020; Friend & Reising, 1993; Trump, 1966). Allocating teams of teachers to teach larger groups of students effectively enabled more students to be taught with relatively fewer teachers.

Team teaching was originally devised by Trump (1966), comprising a format where teachers shared responsibility for lectures to a large group, followed by smaller group and individualised instruction. Different models evolved from the 1960s, which included teachers joint-planning but practicing individual (rather than shared) classroom instruction (Geen, 1985).

Collaborative teaching approaches, sometimes termed co-teaching, has often involved pairing general educators and special educators (employed to work with students with special educational needs) in the same spaces as a strategy for mainstreaming special education (Friend & Reising, 1993). Several organisational models of co-teaching have emerged over time. Bradbeer (2020) describes these teaching scenarios involving pairs of teachers as (a) teaching; (b) supporting colleagues to teach; (c) providing individual students assistance; (d) observation and data gathering; or (e) small-group instruction (p. 89).

As well as being able to more efficiently teach larger groups of students, a range of other benefits have been associated with team teaching. These include increased student-centredness, more personalised and differentiated instruction, improvements in student social interactions, and an ability for students to benefit from multiple teachers perspectives, enhancing opportunities for interdisciplinary programs (Bradbeer, 2020; Easterby-Smith & Olve, 1984; Friend & Reising, 1993; Mackey et al., 2018; Villa et al., 2013).

In general education, collaborative teaching models have been associated with the open plan schools movement of the 1960's to 1980's (Mackey et al., 2018). This was met with some challenges relating to space and practice, as will be further discussed in the next section of this chapter. Mackey et al. (2018) notes that key differences from that period to now include a range of factors such as national curriculum (in Australia and New Zealand) emphasising key competencies, advancements in neuroscience and understanding of learning, collaborative technologies, and research into effective teaching and learning. Adding weight to arguments for the adoption of collaborative teaching as an approach supportive of 21st century skill development, the OECD *Schools for 21st-Century Learners* report advocates for a wider range of pedagogies that extend beyond subject-specific teaching to include cross-curricular content and team teaching (Schleicher, 2015).

School architecture

The traditional school building typologies date back to the 19th and early 20th centuries, when most European countries and the USA established compulsory education. This required the need for physical structures to teach large numbers of students (Burke & Grosvenor, 2008). In the United States, one-room American schoolhouses emerged as early sites of education. These schools accommodated between 50 to 100 students in multi-age groups, with a teacher leading instruction, predominantly through recitation and direct supervision (Hille, 2011; Lackney, 2015b). In more populated urban areas, schoolhouses might contain several self-contained rooms, often with their own entrances from outside.

By 1900 in Europe, most countries had established compulsory education based on the Prussian system of modern schooling developed in the first half of the nineteenth century (Burke & Grosvenor, 2008). The process of education was highly systematised where students were organised and taught around a grade-based curriculum. This required specialist resources and dedicated rooms and tended to be configured as a series of separate classrooms organised around a communal hall (Borrelbach, 2015; Dudek, 2008).

At this time, the teaching philosophy assumed that teachers were there to impart knowledge, and learning primarily took the form of rote memorisation and recall (Hille, 2011). Reflecting this pedagogical approach, school furniture was typically standardised comprising individual desks in rows with a blackboard at the front of the room. This spatially rigid model defined the nature of "cells and bells" schools for "chalk and talk" teaching (Logan, 2015).

By the early 20th century, due to increasing urbanisation and considerable investment in capital building works, school design became a highly regulated endeavour (Hille, 2011). Many large-scale schools across Europe and the USA were developed, with much greater consciousness for the health and safety of students. Design standards were developed reflecting a need to consider lighting, ventilation and fire safety in the design of schools. These standards also reflected cost effectiveness and highly efficient planning models were desired to efficiently educate large numbers of students.

Based on these standards, large schools might typically comprise multiple buildings containing double-loaded corridors lined with classrooms for circulation and mechanical efficiency. Ceiling heights ranged from 12 to 15 feet high (3.7 to 4.6 metres) to accommodate tall windows required for lighting and natural ventilation (Hille, 2011). Classrooms were roughly 32 feet by 28 feet (9.8 metres by 8.5 metres), developed to accommodate rows of desks and chairs. These were oriented so that windows were located to the left of students (to best suit lighting requirements for right-handed students) (Hille, 2011).

A desire for greater health and hygiene resulted in the emergence of a number of innovative school models. In the late 1920s and 1930s outdoor activities were encouraged to support physical health and mental well-being resulting in open-air schools. Jan Duiker's Open-Air School in the Netherlands is one of the first examples of this model comprising an outdoor classroom on each level of a four storey building located between two classrooms, with full-height windows maximising natural light and air (Hille, 2011). Ecole en Plein Air at Surênes (built 1934) comprised classrooms with three walls that could be folded back to the outside maximising fresh air. The architects, Eugène Beaudouin and Marcel Lods also designed lightweight furniture that children could carry into the outdoors (Burke & Grosvenor, 2008).

In contrast, windowless schools were introduced in the late 1960s's in Europe and the USA, to respond to a need for student safety and security during periods of social unrest, and to eliminate noise and visual distractions from the classroom (Hille, 2011). As well, environmental concerns culminating in the energy crisis of the mid 1970s led to retrofitting of earlier schools to improve energy performance (Hille, 2011). Large areas of windows were closed off, impacting on the quality of natural light, ventilation and connection to the outdoors.

In the 1960's, in some countries including Australia, the United Kingdom, Canada, the USA and Israel (Cleveland, 2011), there was also a counter movement towards more open school spaces developed to enable a 'new quality of education' and a 'better educated

workforce' (Kühn, 2011). These schools were designed to respond to the aspiration to enable a broader range of pedagogies catering for more differential rates of student development and interdisciplinary learning (Burke & Grosvenor, 2008; Hille, 2011). Spaces in open plan schools were larger to accommodate multiple classes and more flexible, enabling reconfiguration to provide for different group sizes and team teaching. However, these open learning spaces quickly fell out of favour and walls were reinstated toward more traditional school layouts. Whilst there was not a lot of sound research around these types of learning spaces, nor strong evidence as to why open classroom model schools failed (Imms, 2016a), it is reported that issues such as insufficient sound-proofing contributed to their demise (Burke & Grosvenor, 2008; Hille, 2011; Kühn, 2011). Nevertheless, Kühn (2011) and other researchers note that the main problem was that teachers were not adequately prepared to teach in these types of spaces (Brogden, 2007; Cleveland & Woodman, 2009; Gump, 1980; Lackney, 2015b).

Whilst a range of interesting and innovative models of school design have been explored in the past, the enduring paradigm of school, designed around transferral of knowledge from 'one to many' has perpetuated and remains the dominant model for education today. To this end, Burke and Grosvenor (2008, p. 81) note:

> 'Reading' a school in a landscape is not difficult. Although it may have architectural features in common with other public places and institutions, schools are nevertheless quickly placed and are rarely confused with anything else.

For most people, the building typology of 'school' is well recognised.

Innovative learning environments

Innovative learning environments (ILEs) (OECD, 2013) are spatio-pedagogical environments which extend conventional understandings of school building typologies. They are an "organic, holistic concept that embraces the learning taking place as well as the setting" (OECD, 2013, p. 11). Mahat, Bradbeer, Byers, et al. (2018) note that these environments may be thought of as "the product of innovative space designs and innovative teaching and learning practices" (p. 8). Such environments have also been called 'new generation learning environments' (NGLEs) (Imms, 2016a), 'flexible learning spaces' (Department of Education and Early Childhood Development, 2011) and 'Modern Learning Environments' (MLEs) in New Zealand, (Osborne, 2013). However, the use of the OECD term 'innovative learning environments', referring to both the social and the spatial, is

becoming more consistently adopted for these types of spaces (Benade, 2017; Bradbeer, 2016).

Key education principles associated with ILEs, as defined by the OECD (2013, p. 12), include:

- Making learning and engagement central.
- Ensuring that learning is social and often collaborative.
- Being highly attuned to learner motivations and emotions.
- Being acutely sensitive to individual differences.
- Being demanding for each learner but without excessive overload.
- Using assessments consistent with learning aims, with strong emphasis on formative feedback.
- Promoting horizontal connectedness across activities and subjects, in and out of school.

ILEs are designed to support more student-centred (rather than teacher-centred) approaches to learning (Dovey & Fisher, 2014) and facilitate a variety of collaborative, participatory, and independent teaching and learning approaches (Imms, 2016). They deviate from traditional classroom settings by enabling more diverse pedagogical approaches to help engage students "as active participants in their own learning" (Cleveland, 2009b, p. 74) and to "encourage and enable students to learn in ways that allow them to attain their personal academic and social potential" (Mahat, Bradbeer, Byers, et al., 2018, p. 65). Common characteristics of ILEs are openness, permeable boundaries and diversity in furnishings—aspects intended to support more flexibility in pedagogical approaches, including more collaborative learning and team teaching (Alterator & Deed, 2013; Benade, 2017; Cleveland et al., 2018; Woodman, 2011).

More diverse learning environments, such as can be seen in ILEs, may enable teachers to work together to lead more varied pedagogical practices, anticipated to better meet the needs of a wider cross-section of students. In discussing teacher collaboration, Bradbeer (2016) notes:

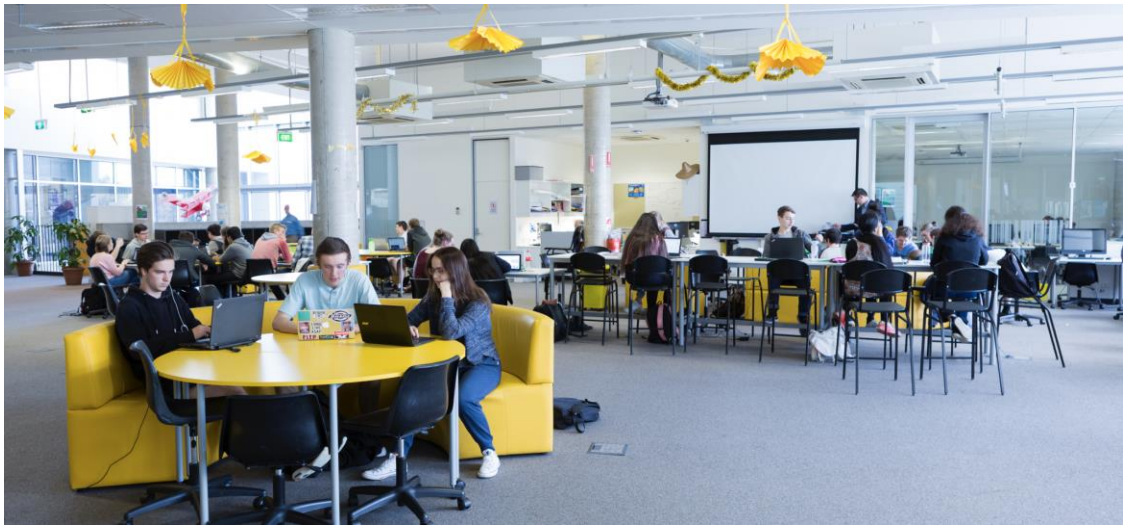
> Designing spaces that co-locate teachers potentially offers: first, the ability for teachers to collaboratively plan, work together and share professional development; second, the opportunity for a team approach to lead towards varying pedagogical alternatives; and third, the idea that a team of teachers

> can better meet the needs of particular groups of students, so that each may receive more attention than when taught by a single teacher. (Bradbeer, 2016, p. 76)

The more open and diverse learning settings of ILEs can be found in schools across the globe, including in Australia, New Zealand, the United Kingdom, Germany, Finland, Spain and the USA (Mäkitalo-Siegl et al., 2009; Nair, 2014). Some of the earliest ILEs in Australia opened in the mid-2000s and include the Australian School of Maths and Science in South Australia (Oliver & Fisher, 2015) (see Figure 4) and Wooranna Park Primary School in Victoria (Frith, 2015) (see Figures 5 and 6). More recent Australian ILEs have been globally recognised as exemplars of school design[7] (refer Figures 7 and 8).

Figure 4

Australian School of Maths and Science (ASMS), Adelaide



Note: Completed 2003. Architect: Woods Bagot. Image courtesy of ASMS.

[7] The Association for Learning Environments awarded the internationally recognised James D. MacConnell award for the Caulfield Grammar Learning Project in 2017, South Melbourne Primary School in 2018, and Marist College, Bendigo in 2020 https://www.a4le.org/A4LE/Programs_Awards/Awards/LEsolutions_Planning_Design_Awards/MacConnell_Past_Winners.aspx

Figure 5

Years 5-6 Studio, Wooranna Park Primary School, Melbourne

Note: Completed 2003. Designed by Mary Featherston Design. Photographer: Dianna Snape.

Figure 6

Prep Grade, Wooranna Park Primary School, Melbourne

Note: Completed 2008. Designed by Mary Featherston Design. Photographer: Dianna Snape.

Figure 7

The Learning Project, Caulfield Grammar School, Melbourne

Note: Completed 2016. Architect: Hayball. Photographer: Dianna Snape.

Figure 8

South Melbourne Primary School, Melbourne

Note: Completed 2018. Architect: Hayball. Photographer: Dianna Snape.

A study by Imms et al. (2017) surveyed schools across Australia and New Zealand and found there was a correlation between ILE spaces and higher levels of student deep learning. The study sought to understand the types of spaces, teaching approaches, levels of teacher mind frames (Hattie & Zierer, 2018) and degree to which students engaged in deep (as opposed to surface) learning across a wide range of schools. The findings were reinforced by (Murphy, 2020) in his recent PhD study of the relationship between teacher mind frames, deep learning and the predominance of ILE spaces. In both studies, Dovey and Fisher's (2014) learning space typologies were used to categorise different school facilities (see Figure 9), from traditional classrooms (Type A) to open plan learning spaces (Type E). Of the 822 respondent schools in Imms et al.'s (2017) study, it was found that 70% were traditional learning spaces (Types A and B), 21% ILE-type spaces (Types D and E) and the remaining 9% a hybrid between the two (Type C).

Although ILEs are still an emerging typology in Australia and New Zealand, the principles behind their design are increasingly becoming embedded into government policy documents such as the Victorian government's *School Facilities Area Schedules and Design Guidelines* (Victorian School Building Authority, 2018) and the New Zealand Ministry of Education's *Designing Schools in New Zealand* guidelines (New Zealand Ministry of Education, 2015). The inclusion of these principles recognises a greater and more mainstream awareness of the potential benefits that the physical design of schools can play in supporting the acquisition of 21st century skills.

Figure 9

Dovey and Fisher's (2014) learning space types, adapted by Cleveland et al. (2016)

Influence of the physical environment on school users

Effects of the physical environment on school users have been found to relate to a range of factors including achievement, engagement, affect, attendance, behaviour and teacher and student well-being (Blackmore et al., 2011; Byers et al., 2018; Weinstein, 1979; Woolner et al., 2007). Fisher (2004) noted that most studies on educational architecture were quantitative attempting "to link student test scores to the condition of school buildings, with little attention paid to qualitative perceptions of students and teachers about their learning environments" (p. 37).

In their literature review on the impact of school environments on learning, Woolner et al. (2007) identified physical factors which had been shown to have positive or detrimental effects on student attainment, engagement, affect (sense of belonging, inclusion, self-esteem and confidence), attendance and well-being. These included temperature, lighting, ventilation, air quality, noise, room and furniture arrangements, display, colour and build quality. However, their review noted that there was an "overall lack of empirical evidence about the impact of individual elements of the physical environment which might inform school design at a practical level to support student achievement" (p. 47).

Woolner et al. (2007) and other researchers (Blackmore et al., 2011; Gislason, 2010) note the complexity of school contexts, where a range of interrelated factors might influence

teachers and students experiences. As well as the physical context, Woolner et al. (2007) noted that pedagogical, socio-cultural, curricular, motivational and socio-economic factors also need to be considered in the development and evaluation of school facilities. Weinstein (1979) also noted this earlier when she suggested that it was important that "researchers not only *acknowledge* the complexity of environment-behaviour relationships but also design and interpret studies to *reflect* this complexity" (p. 600).

The multiple variables which influence teachers and students learning experiences can make it difficult to assess elements in isolation. For instance, Woolner et al. (2007) pointed out that across multiple studies there were divergent perceptions about ideal ceiling heights. Ahrentzen & Evans (1984) found higher ceilings in learning spaces increased teacher satisfaction, as they were perceived by both teachers and students to decrease the sense of crowding. However, other studies have shown negative aspects of higher ceilings in relation to impact on lighting and acoustics in learning contexts. Studies of younger students found that lower ceilings were more beneficial for cooperative behaviour amongst children (Earthman, 2004; Read et al., 1999).

There were similarly mixed findings from studies around the influence of open plan learning spaces from the 1960s and 1970s (Brogden, 2007; Cleveland & Woodman, 2009; Woolner, Clark, et al., 2012). Cleveland and Woodman (2009) describe a study by Traub et al. (1974) which showed inconsistent findings between students in suburban and inner-city open-plan schools. Suburban students "had greater autonomy, more liking for school, and more positive attitudes towards themselves than students in traditional classrooms" (Cleveland & Woodman, 2009, p. 61). Yet, this was not the case for students of inner-city open-plan schools. Other research on open learning environments suggest that they might preference highly able students who are able to demonstrate higher self-esteem and ability to self-regulate in these types of spaces than less able students who may be easily distracted (Ahrentzen & Evans, 1984; Cleveland & Woodman, 2009; Gump, 1980; Woolner, Clark, et al., 2012). Cottrell, referencing Rivlin and Rothenberg (1975), note that children may become socially exhausted in open-plan classrooms and yearn to get away from the stimulation and find respite in a quiet corner.

Cottrell's (1984) study on the effects of open plan school design on student and teacher anxiety revealed the need to understand the influence of multiple factors in school contexts. They compared two school spaces, one traditional and one open plan. Students in the open plan school experienced less anxiety around orientation and wayfinding (e.g. locating classrooms, teachers and their friends) than students in the conventional school.

They were also more anxious about performing competently in front of other students and more apprehensive about getting their work completed correctly. Teachers in open-plan classrooms were dissatisfied and not comfortable teaching in these spaces. However, it was also evident that activities undertaken within the open plan classrooms, and images of spaces being studied show that they were being used in conventional ways. In fact, although the open plan spaces were intended to enable more opportunities for pedagogical diversity, it was found that teachers in the conventional classrooms had more control over their own spaces and more variety in their teaching than those in the more open spaces.

A more recent study by Young and Murray (2017) looked at how school spaces were perceived to support playful approaches to learning. In this study, architects were asked to identify characteristics of spaces they felt supported playful approaches to learning. These aspects were then rated by students and teachers. Characteristics included: having the ability to change spaces, having a variety of spaces defined by different furniture, varying spatial volumes, spaces that could be used in different ways, areas to relax, and connection to the outdoors. Participants in this study felt that in enabling more playful approaches to learning teacher's attitudes and their approach to lessons, student agency and opportunities to experiment and test ideas in a hands-on way were all more critical than the spaces themselves.

The studies mentioned above provide some indication of how the built environment of schools might influence pedagogical experiences. However, few studies address the influence space might have on teaching and learning activities with any specificity. As noted by Gislason (2010), "few studies of any kind have linked school design with the human interactions that govern learning environments, and none drew substantive conclusions about how the use and configuration of instructional space frame teaching and learning" (p. 128). However, some recent studies have addressed this as will be discussed in the following section.

Influence of the physical environment on students. The literature relating the school built environment to student experiences has been investigated through various lenses, including achievement, student engagement, social interactions and competencies, affect and well-being (Barrett et al., 2015; Barrett, Zhang, et al., 2016; Blackmore et al., 2011; Byers, 2016; Byers et al., 2018; Cleveland, 2009a, 2009b, 2011; Woodman, 2011). Cleveland (2009a, 2009b, 2011) and Woodman (2011) both address the benefits of diverse pedagogical practices on student activities and engagement, and how spatial settings within schools can support this. Picking up on the interrelatedness of multiple influences on schools, Woodman's (2011) study explored flexibility in relation to space, time, use and movement, finding that flexibility was "not as a product of building, but as a process of learning" (p. 247). In referencing Buckley et al. (2005), Upitis (2004) and Lackney (1999), Cleveland's (2011) study drew together impacts of ILEs on student well-being, ways in which students learn and student engagement.

Weinstein (1979) was quite cautious about effects of the built environment on student achievement. In her literature review she concluded that although the "weight of the evidence suggests that design features can have a significant influence on students" (Weinstein, 1979, p. 584), it is difficult to find reliable evidence of a definite effect on achievement. Even 40 years later in their systematic review of the effects of learning environments on student learning outcomes, Byers et al. (2018) found few papers eligible for inclusion. Of the 5521 articles reviewed from between 1960 and 2016 only twenty-one papers were included in the study. Only three of these papers reported a statistical effect, and two of them had questionable validity and reliability, as a result of high sampling bias and relatively low quality.

Byers (2016) study was the only one which demonstrated both robustness and effect size. It was based on a five-year longitudinal study in a secondary school comparing traditional classrooms and new generation learning spaces (NGLS) where single-subject repeated measures design (SSRD) was used to isolate space as a variable in relation to student learning outcomes. It found academic results improved by up to 17% in English, 11% in Humanities, and 19% in Mathematics in the NGLS space (Byers, 2016; Byers & Imms, 2016; Byers et al., 2014). Spatial qualities of the NGLS included having polycentric layouts with multiple teacher and student focal points, writeable walls, modular and moveable furniture (including stools, booths, ottomans and portable tables) and bright medium-cool colour palettes used on walls and furniture (Byers et al., 2014).

The Byers (2016) study was undertaken in three stages, with one of the stages situated in a Creative Precinct that brought together disciplines of Creative Arts and Design and Technology. Spatial qualities of this precinct included didactic teaching spaces, specialist technology-enabled workshop areas, and highly flexible inside and outside communal spaces. Results from the study showed greater diversity of learning activities positively influenced student engagement and reduced off-task behaviours, and more effective use of technology showed higher levels of engagement in learning and significant positive impacts on critical thinking, and self-regulation (Byers, 2016).

A Royal Institute of British Architects (RIBA) report (Plotka, 2016) indicated that good school design positively impacted on student behaviour, engagement and well-being. At a school-wide level, features which were seen to have a positive impact included having a sense of identity (for instance through the integration of student displays), lack of overcrowding, social or dining spaces large enough to accommodate all students, and toilets with more visible washing facilities or fully enclosed toilets with sinks in the cubical. At classroom level, features included having a variety of different types of spaces and opportunities to break out from the classroom, good visibility and well-integrated colour schemes.

At primary school level, extensive post occupancy evaluation research in 153 classrooms across 27 primary schools in the United Kingdom by Barrett et al. (2015) showed that 16% variation in learning progress over a year was attributed to physical characteristics of space. These characteristics included aspects of naturalness, individualisation and stimulation. Naturalness related to light (21%), temperature (12%) and air quality (16%). Individualisation included ownership (17%) and flexibility (11%). Ownership referred to elements that distinctly contributed to classroom character, such as display space, well-designed furniture, fixtures and equipment, chairs and desks that were comfortable, interesting and ergonomic, and personalisable components such as coat pegs and lockers.

Flexibility referred to spatial diversity to support individualisation and enable different modes of learning and an ability to accommodate future changing pedagogical needs. The aspect of stimulation included colour (12%) and complexity (11%), referring to adequate visual diversity within classrooms. From the same study, Barrett, Davies, et al. (2016) also found that ‘links to nature’ resulting from visual or physical connections to the outdoors, or the use of natural materials were associated with reduced stress levels, greater self-discipline, higher test scores, increased concentration and higher levels of creativity in writing.

Spatial qualities, as discussed above, that have been identified to support student outcomes are summarized in Table 2 below. As Byers et al. (2018) note, assessments favouring academic progress in literacy and numeracy were most common with few robust studies assessing the physical environment on student learning in relation to 21st Century skills of creativity, critical thinking, communication, collaboration and problem-solving.

Table 2

Spatial qualities relating to student learning outcomes

Author	Spatial qualities	Impact
Young and Murray (2017)	• Ability to change spaces • Variety of spaces • Different furniture • Varying spatial volumes • Spaces that can be used in different ways • Areas to relax • Connection to the outdoors	Enables playful approaches to learning
Byers (2016)	• Polycentric layouts with multiple teacher and student focal points • Writeable walls • Modular and moveable furniture • Bright medium-cool colour palettes • Flexible inside and outside communal spaces	Academic improvements in english, humanities and maths
Plotka (2016)	• Student displays • Lack of overcrowding • Social or dining spaces large enough to accommodate all students • Toilets with more visible washing facilities or fully enclosed toilets with sinks in the cubical • Variety of different types of spaces • Good visibility • Well-integrated colour schemes	Improved student behaviour, engagement and well-being

Barrett et al. (2015) Barrett, Davies, Zhang, and Barrett (2016)	• Light • Temperature • Air quality • Display space • Well-designed furniture, fixtures and equipment • Comfortable and ergonomic chairs and desks that were comfortable • Personalisable components • Visual or physical connections to the outdoors • Use of natural materials	Academic achievement in reading, writing and mathematics

Influence of the physical environment on teachers. Several researchers have investigated teachers' experiences in learning spaces in relation to well-being, productivity and adaptation (Alterator & Deed, 2013; Deed et al., 2020; Deed & Lesko, 2015; Plotka, 2016).

The RIBA *Better Spaces for Learning Report* (Plotka, 2016) revealed that poor learning environments put a strain on teachers and make it harder to retain the best staff. Aspects such as teacher well-being and productivity were influenced by how spaces are designed. Good lighting, ventilation and spacious learning areas were seen to influence teacher well-being, whereas having space to carry out planning, preparation and assessment, and being able to adjust the physical environment to create comfortable working conditions supported teacher productivity.

Alterator and Deed (2013) investigated teacher reaction and adaptation to the affordances of open space environments. Thematic categories identified associated with teachers perceived affordances were flexibility of space, increased visibility and scrutiny, and a de-emphasis of hierarchy. Flexibility meant that spaces could accommodate a range of teaching and learning approaches including interdisciplinary, inquiry-based, personalised and community learning (Alterator & Deed, 2013; Deed & Lesko, 2015). Visibility throughout spaces meant that teachers could be seen and accessed by students, and moveable furniture enabled students and teachers to work less hierarchically and more autonomously, either one-on-one or with small or large groups. Alterator & Deed (2013) found that from teacher's perspectives "the flexibility of open spaces afforded collective practice, visibility and scrutiny afforded a team orientation, and the de-emphasis of hierarchy afforded increased interactions and the democratisation of authority" (p. 8). They identified that "teacher

adaptability is a key feature of successful engagement with the affordances of open plan settings" (p. 8) and exhibits a relationship to teacher inter- and intra-personal skills.

The challenges of adapting to ILE spaces. With the emergence of new types of learning spaces, it was initially perceived that new spaces would bring about new practices (Joint Information Systems Committee (JISC) Development Group, 2006; Oblinger, 2006). A statement in the *Designing Spaces for Effective Learning* report notes "Spaces are themselves agents for change. Changed spaces will change practice" (Joint Information Systems Committee (JISC) Development Group, 2006, p. 30). However, it appears that the enduring traditional school typology has embedded a dominant and resilient teacher-centred pedagogy that has proven to be difficult to shift in the transition to ILEs.

Studies investigating teachers' use of varied and flexible learning spaces largely illustrate the difficulties associated with changing practice amidst expectations about the potential of ILEs to support contemporary pedagogies (Benade, 2017; Cleveland & Woodman, 2009; Cotterell, 1984; Deed & Lesko, 2015; Fisher, 2004; French et al., 2019; Lackney, 2008; Rivlin & Rothenberg, 1975; Woolner et al., 2007). Bradbeer (2016, p. 78) noted that "teachers have generally worked in isolation with high levels of professional autonomy". Subsequently, spaces designed to support more collaborative practices can be hindered by entrenched cultures, practices and a lack of vision for 'doing things differently' (Cleveland, 2018; French et al., 2019).

While ILE spaces are designed with the intent to support contemporary teaching and learning practices, researchers have noted that offering ILEs alone will not bring about significant changes to teacher practice (Alterator & Deed, 2013; Blackmore et al., 2011; Cleveland, 2011; Gislason, 2010; Halpin, 2007; Lackney, 2008; Leighton & Byers, 2020; Mulcahy et al., 2015; Woolner, Clark, et al., 2012). Lackney (2008) suggests that teachers "continue with traditional patterns of instruction despite innovations in school design" (p. 136), 'making do' with their learning spaces rather than recognising the physical environment as a resource to support teaching goals.

In discussing open-plan schools "as containers for conventional as much as for more enlightened modes of teaching and learning", Halpin (2007, p. 251) notes that "there is not a straightforward causal link between building plans for schools and progressive teaching approaches being undertaken within them". He notes that the key variable for the success of ILEs "is not space, but teachers' intentions and educational aims in terms of how they go

about using it" (Halpin, 2007, p. 251). In fact, as noted earlier in this chapter, the demise of the open-plan schools movement can largely be attributed to the misalignment between teacher practice and the spaces themselves.

The need to support teachers in using new ILE spaces. More directly, research suggests that there is a need to support teachers to work effectively in new learning spaces (Blackmore et al., 2011; Brogden, 2007; Cotterell, 1984; Deed & Lesko, 2015; Halpin, 2007). In his comparative study on open-plan and traditional school spaces, Cotterell (1984) noted that teachers needed to be empowered to adapt the environment to suit their pedagogical needs and goals and required a "fundamental change in their thinking about the influences of environments on behaviour" (p. 475). Further, Fisher (2004) suggests that "teachers in all educational sectors will continue to resist change and revert to the time-tested concept of the classroom unless it can be demonstrated that the physical learning environment can influence learning outcomes" (p. 37). He notes that "there has been no sustained attempt at a holistic change to approaches to educational reform that integrates all the forces acting on it and especially including the power of space" (p. 37). In Blackmore et al.'s (2011) literature review on the connection between the built environment and student outcomes, they noted a gap in the literature in relation to the need to support teachers in the process of change in order to optimise innovative pedagogies in new learning spaces.

As discussions about space are not common in educational discourse, teachers may not readily perceive links between the physical environment and effective teaching and learning (Cleveland, 2011; Lackney, 2008; Leighton, in press; Leighton & Byers, 2020; Newton, 2009; Woodman, 2011). In fact, as Willis et al. (2013) note that there is "little known about the experiences of teachers and learners in newly designed learning spaces, and whether the potential for reimagined pedagogies is being realised" (p. 1).

Up until more recently, the focus of developing ILEs has tended to be on the buildings themselves rather than the practices that take place within them. French et al. (2019) noted that "the process and preparation required to transition is often ignored by the schools themselves, resulting in little emergence of new teaching and learning practices, despite the new spaces" (p. 3). As there is little known about how new learning spaces are being experienced, this would also allude to the fact that "little is known on how to shape elements of the learning environment for proper teacher preparation" (French et al., 2019, p. 3).

Strategies to empower teachers to transition to ILEs. A few papers suggest how to support teachers to adapt to new ILEs. Deed & Lesko's (2015) study noted "that teachers' memory and experience in conventional spaces was deeply ingrained and provided a validated set of approaches to teaching" (p. 222). Issues such as organisation, conformity, order and control, caused concern within these new spaces. As open learning spaces are more dynamic than traditional classrooms, with greater movement and flow of teachers and students into and out of these spaces, Deed and Lesko (2015) suggest the need for an "agreed set of values and approaches" or "coherent set of practices" (p. 226) to enable effective space usage. Gislason (2010) relates this to staff culture, in describing a "system of shared values and beliefs" that underpins school organisation and behavioural norms" (p. 129).

Saltmarsh et al. (2015), however noted that whilst implementing structures to support change could be helpful, there could also be a danger of too much structure impinging on the learning goals set out for these types of spaces. They noted that rather than strictly define structures, spatially responsive pedagogic practices occurred where teachers and students had agency in their teaching and learning, enabling them the willingness to experiment and take risks, helping them adapt to new spaces.

Empowering teachers to take risks also featured in French et al.'s (2019) case studies of successful school transitions to ILEs. They found four key themes: 1) culture, relating to attitude towards risk-taking and reflection; 2) nudges, the design and organisational features that encourage particular behaviours; 3) structure, embracing new procedures and systems; and 4) expectations and accountability (French et al., 2019).

Deed et al. (2020) found a series of drivers, influences and indicators of adaptation. Whilst they noted that the process of adaptation is complex and non-linear, they identified three key phases which are encapsulated into an explanatory model of teacher adaptation in response to the affordances of new learning spaces. These three phases of a) awareness, b) experimentation and c) coherence, are defined in relation to enactment dimensions of perception, reasoning and practices. The three phrases relate to consciousness of contextual triggers, teacher agency that is reflexive and relational, and achievement of resolved understandings and practices.

Lackney (2008) undertook an action research study to determine whether training, research and action activities would improve teacher environmental competence, or "the ability to understand and effectively use physical instruction space for pedagogical

advantage" (p. 133). This study involved interviews with teachers to understand the perceptions of their school environments followed by workshops to allow participants to collectively examine assumptions made. A scale was used to assess levels of teacher environmental competence from 'highly proficient' to 'lack of proficiency' across the stages of the study. It was found that teachers exhibited little awareness of the influence of the physical setting on teaching practice and had little interest in improving conditions, rather accepted existing circumstances. This study indicated that there was little impetus from administrative levels for teachers to develop their environmental competence.

Leighton (in press) suggests that influenced by their past experiences, current environments and imagined futures, "people can only perceive what they know what to find" (p. 27). However, "spatially adept teachers can learn to manipulate space to actively promote a range of student outcomes" (Leighton & Byers, 2020, p. 31). Leighton (in press) argues that an environmental competence scale (Lackney, 2008) misses the complexity of individual teacher contexts and erroneously elevates the position that the physical space is "the sole determinant in the teaching and learning transaction" (p. 12). She proposes a conceptual framework for teacher spatial competence which can be measured via a 'Teacher Spatial Competency Instrument (TSCI)' used to observe teacher action relative to spatial competency behaviour which is analysed in relation to teachers' personal cognitive responses and their situated environmental imagination.

Osborne (2018) stresses the importance of being able to test strategies for new spaces in advance of inhabiting a new ILE. He advocates for the development of a "small, safe prototype" (p. 159) which would enable teachers to grow capability in key areas. These would include being able to facilitate conversations between colleagues about the use of space, to allow staff to adjust their mental models to prepare for change ahead and to gather data about what is and isn't working ahead of time (Osborne, 2020). He defines three types of prototypes: 1) systems prototypes, which explore non-physical elements of teaching and learning (e.g. timetables or software), 2) ephemeral prototypes which help people visualise new spaces (such as models or mock ups), and 3) enduring prototypes which involve minimal adaptions to existing spaces - essentially a 1:1 prototype (Osborne, 2020).

User participation in design and transition to ILEs

A few papers have addressed participation of school users in the design and transition to new ILE spaces (Blackmore et al., 2011; Cleveland & Woodman, 2009; Frelin & Grannäs,

2020; Kuuskorpi & González, 2011; Woolner et al., 2007; Woolner, McCarter, et al., 2012). Involving teachers and students in the design process of developing new learning spaces is thought to garner greater support and a sense of ownership over spaces and the pedagogical initiatives envisaged as part of using them. A number of scholars such as Cleveland and Woodman (2009), Kuuskorpi and González (2011), and Blackmore et al. (2011) note benefits of teacher, student and school community participation in design, however there appears to be a gap in the literature as to how such a process could impact on teacher mind frames (Hattie & Zierer, 2018) and use of ILEs.

In Byers (2016) study, which showed academic improvements as a result of ILE spaces, it was noted that considerable stakeholder consultation during design was likely to have contributed to positive outcomes and aligns with the idea that teachers and students need to be involved in the change process in order for success to be achieved (Woolner, Clark, et al., 2012). Passon et al. (2008), referencing Rutter (1994) and Sanoff (1994), reinforce this concept stating "projects that allow children and youth to participate in the construction and operation of their school are positively correlated with greater academic achievement, higher attendance, and better behaviour" (p. 78).

Frelin and Grannäs (2020) suggests that participatory design methods can enhance the fit between the design and use of schools. They note that constraining factors in the design of school environments include teacher's abilities to evaluate and provide feedback on design documentation. They suggest 'Pre-Occupancy Evaluation (PreOE)' as a strategy that could be used during design phases to support teachers to recognise the potential use of designed spaces, enabling them to provide feedback to designers on adaptations that might be required prior to construction. In their study, they developed a Teachers' Evaluations of Affordances in Learning Environments (TEALE) model to support interprofessional understandings in participatory design, which could also be used by teachers to plan lessons together within new learning spaces.

In another study, Woolner, McCarter, et al. (2012) explored how participatory methods engaging with teachers and students could facilitate engagement and support change. They noted that there was little detailed reflection on the impact of participatory methods in influencing sustained change in learning environments. They found that rather than 'top down' approaches to change, that "a key to enacting sustainable educational change lies in facilitating collaborations and discussions so that changes to space and organization are coupled with changes in teaching and learning practices and based genuinely on the development of shared understandings of all those involved" (p. 57).

Affordances

Referring to the complementarity of environment and user, the term ‘affordance’ was originally developed by American Psychologist James Gibson in 1966 (Gibson, 1966). Gibson developed the concept of affordances to address shortcomings in conventional understandings of perception (Heft & Richardson, 2017). At the time, understandings of how one perceived the world was considered to be through indirect experience. That is, through sensory stimulation (such as from light) creating a mental construct of the world. However, as a proponent of direct perception, Gibson believed that the environment directly indicated possibilities for action. Gibson’s most cited definition for affordances derives from his 1979 book *The Ecological Approach to Visual Perception*:

> The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment. (Gibson, 1979, p. 127)

Since then, affordance theory has been applied and re/interpreted by researchers from varying fields. These have included psychology (Chemero, 2003; Costall, 1995; Gibson & Pick, 2003; Gibson, 1979; Greeno, 1994; Michaels, 2003; Reed, 2012; Rietveld & Kiverstein, 2014; Shaw et al., 1982; Stoffregen, 2000a, 2000b; Turvey, 1992; Warren, 1984), technology (Gaver, 1991; Leonardi, 2013; McGrenere & Ho, 2000; Oliver, 2005; Pea, 1997; Shaw, 2017), human-computer interaction (HCI) (Norman, 1988), anthropology (Ingold, 2008) and children’s environments (Aziz & Said, 2015; Heft, 1988; Kyttä, 2002, 2004; Little & Sweller, 2015; Withagen & Caljouw, 2017; Wyver & Little, 2018). To a lesser degree, it has also featured in research within built environment fields (Atmodiwirjo, 2014; Jelić et al., 2016; Kim et al., 2011; Kim et al., 2007; Koutamanis, 2006; Maier et al., 2009).

In fact, there is an abundance of literature on affordances. However, multiple and sometimes conflicting interpretations in various disciplines can make it challenging to understand the applicability of the concept in architecture and school design. To clarify the concept for this study, this section of the literature review is set out in three parts: 1) key concepts of affordance theory, 2) use of affordance theory in architecture, and 3) application of affordance theory in school design.

Key concepts of affordance theory

Critiquing affordances, Oliver (2005) lamented that the term had become muddled such that "it is now too ambiguous to be analytically valuable" (p. 402). However, recognising the value of affordances a bridge between design and use of learning spaces, key concepts associated with the theory are summarised below. These concepts are intended to aid in the application of affordances to a learning environments context. The key concepts relate to relationships and action possibilities, perception, abilities, intentions, socio-cultural context and learning.

Relationships and action possibilities. As indicated by Gibson (1979), core to the concept of affordances is the complementarity of environment and user and the potential action possibilities that arise from this relationship. Commonly used examples of affordances have included handles: for example, the handle of a cup enabling it to be picked up, or the design of door handles allowing people to open doors in different ways. An example from HCI design might include on-screen 'buttons' that can be clicked or a scrollbar that can be dragged to achieve different functions.

Harwood and Hafezieh (2017) note that "affordances are not properties, but properties provide affordances". The use of the term properties is common amongst many authors, however Gibson used both 'properties' and 'qualities' in describing the environment.

Perception. Perception is critical to the concept of affordances. Gibson suggested that while an affordance is required to be perceived for an action possibility to occur, the affordance exists regardless of whether it is used or not. Thus, the environment comprises properties which offer possible functions whether or not they are noticed or perceived by the observer. Until used, they may remain latent in the environment. (Gibson, 1979)

> The affordance of something does not change as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived. An affordance is not bestowed upon an object by a need of an observer and his act of perceiving it. The object offers what it does because it is the object it is. (Gibson, 1979, p. 138)

The role of perception has been debated in affordances literature. For example, in the context of HCI design, Norman (1988) described affordances as including both perceived and actual properties:

> ... the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used … Affordances provide strong clues to the operations of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing. When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction needed. (Norman, 1988, p. 9)

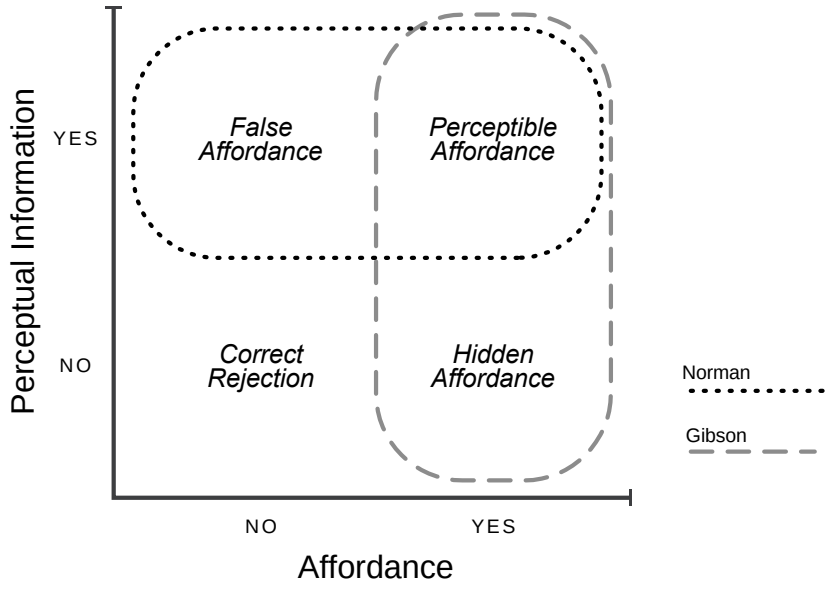
It should be noted that the way people use affordances in digital applications is a critical consideration for how technologies are designed, and assisting users to perceive the affordances of interfaces is core to how HCI design is approached (Norman, 1988; Pea, 1997).

Norman felt that HCI designers care "more about what actions the user perceives to be possible than what is true" (Norman, 1999, p. 39). However, his conception of affordances being both perceived and actual/real, has caused some confusion and misunderstanding as it implies that an affordance only needs to be perceived in order for it to exist. In recognising the ambiguity of his original reinterpretation, where an affordance could be perceived but not be real, he subsequently revised his definition in a later paper to refer to 'perceived affordances' (Norman, 1999).

Gaver's (1991) affordances matrix provides some clarity to Gibson's and Norman's interpretations. Relating affordances to perceptual information, it defines four categories of affordances (perceptible, hidden, false and correct rejection) and identifies whether an actual (real) affordance exists and whether or not there is perceptual information for it (see Figure 10).

Figure 10

Gaver's affordance matrix showing Gibson and Norman perspectives



Note: Adapted from Gaver (1991).

Gaver's diagram showed that affordances "exist whether the perceiver cares about them or not, whether they (are) perceived or not, and even whether there is perceptual information for them or not" (Gaver, 1991, p. 2). Norman's definition of 'perceived affordances' invariably includes Gaver's identification of a 'false affordance' i.e. perceived information which in reality does not afford an action possibility. In order to illustrate Gaver's affordances, Table 3 (below) provides some tangible examples of the four different categories as defined in his matrix. These have been translated from a set of diagrams by Nye and Silverman (2012) into text.

Table 3

Categories of affordance as interpreted by Nye and Silverman (2012) – translated from diagrams into text (Young & Cleveland, n.a.)

Category of affordance (Adapted from Gaver, 1991)	**Context**	**Example**
Perceptible Affordance	Perceptual information is available for an affordance - it can easily be seen.	A functioning door that opens to provide access to another space.
Hidden Affordance	Affordance exists but is not obvious to find.	A secret panel which can be opened to provide access to

		another space.
False Affordance	Something looks like an affordance but it's not.	A drawing of a door in a solid wall which doesn't function as a door at all.
Correct Rejection	No perceptual information, nor an affordance exists.	No reference to a door, nor access to another space.

The notion of 'design affordances' is addressed by Van Osch and Mendelson (2011), who define three types of affordances relating to the field of technology: *designed affordances* i.e. 'the set of affordances that is perceived and recognized by developers'; *improvised affordances* i.e. 'the set of affordances that is perceived and recognized by users and therefore emerges while using the artifact'; and *emergent affordances* i.e. "the set of affordances that is neither anticipated and designed by developers nor actively recognized and improvised by users in use, but which nonetheless has an impact on the interactions between artifacts and actors" (p. 2). Whilst these refer to technological contexts, these ideas can be translated to the field of architecture and interior design, where spaces are designed for intended purposes that may or may not be recognised or used by users.

Abilities. Ability and body scale are one of the determining factors as to whether one is able to perceive or use an affordance. Warren's (1984) empirical study on the affordances of stair climbing showed that an individual's ability to recognise affordances is body-scaled. In this study, he demonstrated that affordances of stair climbing were related to the ratio between riser-height and leg-length. Other studies have shown relationships between aperture sizes and the likelihood of people going through them relative to their body sizes (Warren & Whang, 1987). The terms 'effectivities' (Shaw et al., 1982) and 'aptitudes' (Snow, 1992) have also been used to describe abilities in relation to affordances (Greeno, 1994).

In relation to abilities, this is again an area where Gibson and Norman might appear to diverge. McGrenere and Ho (2000) note that "Gibson claims that the existence of affordances is independent of an actor's experience and culture. Norman, on the other hand, tightly couples affordances with past knowledge and experience. The frame of reference for Gibson is the action capabilities of the actor, whereas for Norman it is the mental and perceptual capabilities of the actor" (p.3). In clarifying this aspect, McGrenere and Ho (2000) note that "the existence of the affordance is independent of the actor's experiences and culture, whereas the ability to perceive the affordance may be dependent on these" (p.2).

Heft's (1988) research into children's environments illustrated a range of affordances perceived by children that may not be perceived by larger or less able-bodied adults. Heft (1988, 1989) and other researchers in the field of children's environments (Aziz & Said, 2015; Kyttä, 2002, 2004) differentiate between *potential* affordances, which may remain latent in the environment and not seen by individual users, and *actualised* affordances. The notion of actualisation was introduced by Heft (1989), who suggested that of all potential affordances only some are actualised (perceived and utilised) at any given time depending on the intent of individuals.

The idea of latent affordances is similar to what Turvey (1992) describes as dispositional properties. He notes "whereas an affordance is a disposition of a particular surface layout, an effectivity is the complementing disposition of a particular animal" (p.179). Gibson's view of affordances is one of direct perception, one in which an affordance exists whether perceived or not. However, for Norman the existence of an affordance depends on the properties of both the object and agent: "an affordance is a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used … Whether an affordance exists depends upon the properties of both the object and agent" (Norman, 2013, p. 11).

Intentions. In his paper *Affordances and the Body,* Heft (1989) noted that affordances don't cause behaviours. Rather, there is need for intentionality on the part of the perceiver (beyond the body-scale relationship first identified by Warren) to take up action possibilities. In describing objects that offer multiple affordances, Heft suggested that the affordances that different individuals perceive relate to intentional processes of the perceiver. For example, spoons are used for eating but they can also be used for digging in the dirt, or boxes can be used for storing things, but for a cat they afford hiding in.

Heft promoted a functional rather than a form-based language to describe affordances relative to their environmental quality and user's ability. This offers a greater precision in which to understand the potential of an environment reducing the likelihood of misunderstanding. For instance, some elements like trees or fences might be 'climb-on-able', or other lower elements such as benches or stone slabs could be described as 'sit-on-able'. Using a functional language, one is able to perceive an environmental context with much more nuance. As Heft (1988) explains, using a form-based language one might describe a landscape consisting of trees and grass. However, a functional description offers a much

richer perspective of an environment. For example, for a child, the same landscape could comprise some trees that are climb-on-able, other trees might have limbs that are swing-on-able, or trunks that are good for hiding behind, and the flat area of grass could be perceived to be good for running across.

Socio-cultural context. A number of researchers discuss the socio-cultural contexts which influence individual's understandings of affordances and their ability and intentions to using them (Costall, 1995; Gaver, 1991; Leonardi, 2013; Lindberg & Lyytinen, 2013; McGrenere & Ho, 2000; Norman, 1988, 1999; Ramstead et al., 2016; Rietveld & Kiverstein, 2014). Gaver notes that affordances are influenced by an observer's "cultures, social setting, experience and intentions" (Gaver, 1991, p. 81) and as noted by Harwood and Hafezieh (2017), any analysis should establish "the nature of the complex of factors that shape social interaction" (p. 8).In discussing technology affordances, Leonardi (2013) defines three types of affordances: individualised, collective and shared. *Individualised* affordances refer to a unique affordance relative to an individual, a *collective* affordance refers to diverse understandings and uses of a suite of affordances which are used by a group of people to enable a collective task, and *shared* affordances refer to a group of individuals having a common understanding of use of affordances. It is the latter which Leonardi posits is required in order for 'network change' to occur that is meaningful at organisation level.

Also from a technology perspective, Lindberg and Lyytinen (2013) introduced the concept of 'affordance ecologies', where the ecology metaphor comprises three domains: infrastructure, organization and practice. The *infrastructure* domain refers to "basic information technologies and associated organisational structures that provided a field of tools available for use. The *organizational* domain comprises institutional arrangements which guide how technologies are understood and used, and the *practice* domain to the practices within which technologies are used within organisations.

There are variations in how researchers have considered the ecologies in which affordances are found. Ramstead et al. (2016) define 'cultural affordances' comprising 'natural affordances' and 'conventional affordances'. Whilst *natural* affordances refer to the original Gibsonian definition relating environment and user, *conventional* affordances relate to possibilities for action influenced by expectations, norms, conventions and cooperative social practices. This definition highlights a distinction between the social/cultural and natural, whereas Harwood and Hafezieh (2017) talk about the complexity and dynamicity of

affordances toward a more holistic and integrated ecological perspective. The integrated and interrelated nature of affordances is described by Ingold (2008) as a relational perspective between organisms and things. Ingold speaks of "an ecology of threads and traces" (p. 1805) — an entanglement which is "not a network but a meshwork" (Ingold, 2008, pp. 1805, 1807).

Highlighting the socio-cultural dimension, Costall notes that we "experience objects in relation to the community within which they have meaning" (Costall, 1995, p. 472). Norman (1999) describes cultural constraints in the context of perceived affordances as conventions shared by a cultural group about what people believe and do. Norman states "a convention is a cultural constraint, one that has evolved over time. Conventions are not arbitrary: they evolve, they require a community of practice. They are slow to be adopted and, once adopted, slow to go away" (p. 4).

Rietveld and Kiverstein (2014)[8] (drawing from Wittgenstein (1953)) introduce the concept of affordances being part of a sociocultural "form of life", suggesting that individual's abilities are "acquired through training and experience in sociocultural practices" (Rietveld and Kiverstein (2014, p. 340):

> We believe it is more precise to understand abilities in the context of a form of life. In the human case, this form of life is sociocultural, hence the abilities that are acquired by participating in skilled practices are abilities to act adequately according to the norms of the practice. (Rietveld & Kiverstein, 2014, p. 330)

Learning. The socialising of affordances relates to how groups of people understand affordances in shared and collective ways (Leonardi, 2013), and how they learn to use them. In writing about children's perceptual learning, Eleanor Gibson[9] and Prick suggested that discovering affordances "may require much exploration, patience, and time" (Gibson & Pick, 2003, p. 17). Other researchers have also described peoples' perceptions and understandings of affordances as being culturally-specific, such as when learning how to use particular objects takes place through direct instruction or observing others (Heft, 1989) or learning through imitating others and playful discovery in solitary activity (Pea, 1997).

[8] Erik Rietveld is a Philosophy academic at the University of Amsterdam, however is interesting in the context of this thesis as he is also a Founding Partner along with his brother, an Architect, of a design practice called RAAAF (Rietveld Architecture-Art-Affordances). RAAAF is a multidisciplinary and experimental studio that makes site-specific art installations at the crossroads of visual art, architecture and philosophy. https://www.raaaf.nl/en/

[9] Eleanor Gibson was married to James Gibson who coined the term affordance and was also a prominent Psychologist.

Lindberg and Lyytinen (2013), referencing Gaver (1991), discuss learning processes and the benefits of an affordance lexicon to allow users interpretations to change and for them to successively pick up more 'effective' affordances. To this end, (Kyttä, 2002, 2004) added to the notion that affordances may be shaped by a range of environmental, cultural and policy influences, helping to determine whether affordances may become available and relevant to users.

Affordances in architecture

Gaver (1996) noted that "interior decoration relies on designing affordances" (p.11). Gibson (1979), however, felt that architects and designers lacked a theory of affordances to encompass their understanding of materials into a system. He noted that:

> A glass wall affords seeing through but not walking through, whereas a cloth curtain affords going through but not seeing through. Architects and designers know such facts, but they lack a theory of affordances to encompass them in a system. (Gibson, 1979, p.59)

In 1989, Heft commented that affordances are the product of the architectural design process ideally anticipating functionally suitable places for a particular user group. Yet, although there is a strong argument for a more affordance-based approach to the design of environments, there is a lack of literature around the experience of users within spaces. Heft reiterated this perspective in 2010 when he wrote:

> Designers interested in how particular environments are utilized and experienced quite reasonably might turn to the environmental psychology research literature for guidance. They are likely to be disappointed. Although there is an extensive literature addressing how individuals assess environments (or rather environmental surrogates) on rating scales, information is sorely lacking about how environments are experienced by users in the course of action. (Heft, 2010, p. 22)

From an architectural perspective, Boys (2009) supports this highlighting that case studies tend to discuss the intentions, planning and design of spaces rather than evaluate how they are used.

As noted above, while affordances have been discussed broadly across a range of fields, affordance theory has been less present in architectural discourse. Figure 11 (below) represents a selected timeline of affordance theory. It shows parallel discourses with respect to the application and development of 'affordance thinking', highlighting varied trajectories of the theory within selected domains.

Authors from psychology/philosophy, technology/HCI, children's outdoor environments, architectural/interior design and learning environments contexts are represented. As shown from the number of citations, it is clear that the discourse in psychology/philosophy and technology/HCI is far more extensive than in architecture and interior design. Of the literature that exists in the built environment fields, the focus has primarily been on relationships (between environment and user) and action possibilities, rather than towards aspects of perception, ability, intentions or socio-cultural contexts.

Typically, one would consider the foundational aspect of relationships between environment and user central to architectural design. In discussing affordances, Koutamanis (2006) noted that there is an "assertion that the capable architect caters for such aspects intuitively" (p. 347). However, he added that as designers perceive through an aesthetic lens their priorities in design contexts may not necessarily be the same as users. Although there might be an assumption that architects naturally address affordances, as "users can be flexible, adaptable and tolerant to design limitations despite constant irritation and frustration" (2006, p. 357), the built environment may not always be designed in ways that reflect user's needs, nor their affordance (action possibility) requirements.

Sporrel et al. (2017) also discussed designers competing considerations of aesthetics and function in relation to playground design. Sporrel et al. (2017, p. 136) noted that "designers are often driven by aesthetic motives", however such motives may not align with children's perspectives on the playability of play equipment.

Figure 11

Selected timeline of affordance theory development

Note: Authors (with more than five citations) who have influenced the understanding and definition of affordance theory within the field of learning environments have been selected for inclusion into this timeline.

Koutamanis (2006) states that as architects can be selective in what they deem critical and "insensitive to practical problems that conflict with higher, usually aesthetic norms" (p. 357), a deeper understanding of affordances in architecture would be helpful. He felt that "the main target of affordances in architectural design is the enrichment of the architects' perception" (p. 361). In a similar vein, Heft (1981) noted that "it must be disconcerting for professionals working on a design problem to learn (much less to believe) that the environments they are constructing are not perceived veridically by their clients" (p. 240) and that if design professionals better understood the nature of affordances, and the relationship between latent affordances and the actual use of environments, they may pay more attention to the ways in which information may be designed into settings to enable use. Heft felt that the descriptive language which designers use, which is largely form-oriented, may hinder their ability to adequately incorporate function into their designs (Heft, 1988).

Jelić et al. (2016) investigated neurophysiological perspectives on the relationship between human behaviour and the built environment. They explored how immersive virtual reality can be used to explore human perceptions of architectural environments as a means for architects to suitably design for users changing needs. Addressing evolving needs, Koutamanis (2006) suggested that not only would an affordance perspective better ensure alignment in understanding between designers and users/clients, but correlation of designers' and users' perceptions would also promote the potential for design innovation and reduce "the danger of falling back to stereotypical solutions and arrangements" (Koutamanis, 2006, p. 357).

Maier et al. (2009) argued that the lack of references to affordances within architecture relates to historical separations of form and function in architecture dating back to the writings of Vitruvius, in which form (firmitas), function (utilitas), and beauty (venustas) were considered separate but competing requirements. They proposed that the concept of affordance could be used as a conceptual basis to unite the originally separate Vitruvian ideas of form and function.

Some researchers within architecture and interior design disciplines suggested a terminology for affordances in the built environment (Kim et al., 2007; Maier et al., 2009). For example, Maier et al. (2009) defined direct and indirect affordances. They suggested that artefact-user affordances (AUA) are direct affordances and reflect the relationship between environment and user. They also proposed artefact-artefact affordances (AAA), which were indirect affordances referring to many of the components required for buildings to function. For example, walls afford support to roofs, or building services such as lighting, heating,

cooling, ventilation, fire protection etc. are inherently required for environments to operate successfully. The definition of AUA aligns to Gibson's original definition of affordances, however AAA would appear to primarily relate objects with objects (or artefacts with artefacts) aligning more to "events" (Stoffregen, 2000a) than affordances. Stoffregen (2000a) defines events as "static and dynamic properties of objects and surfaces defined without reference to behaviour and not scaled relative to action-relevant properties of the animal" (p.15).

Maier felt that application of the affordance concept would provide a means for comparing actual behaviours with intended affordances. Maier et al. (2007) used the AUA and AAA definitions as part of the development of an Affordance Structure Matrix (ASM), which they proposed to enable the analysis of environments. Similarly, Galvao and Sato (2005) developed a Function-Task Interaction Method (FTIM) to analyse affordances in product design. Kim et al. (2007) adapted this to suit interior design contexts, adding aspects that included the 'space' in which objects are located, as well as interactions between 'people'. In all, they proposed three aspects to consider:

a) *space* – including building components such as floors, ceilings, columns, walls, as well as door and window openings which enable the flow of movement between spaces.
b) *objects* – including fixtures, fittings and furniture, as well as technological equipment and personal belongings, such as paper and pens.
c) *social activities and tasks* – including a range of diverse interactions between people (human-human interactions), including communication, socialising, discussion and presentations.

Atmodiwirjo (2014) discussed the 'spatial environment' referring concurrently to physical properties of spaces and objects, as well as the arrangement of spaces and objects. Bringing a spatial environment, or aspects of space, objects, and social activities and tasks, into a built environment context enables a more contextual understanding of the concept of affordances in architecture.

Kim et al. (2011) suggested that designers need to recognise different user types and their various activities in order to provide adequate affordances in the design of space. They used the Personal Creativity Modes Test (PCMT) developed by researchers at Stanford University to study how people performed a range of common tasks within a lobby space and

found that some participants perceived affordances not originally considered by the designers of the space, particularly those who had 'transforming' or 'synthesizing' creativity modes. This aligns to Van Osch's (2011) notion of 'design affordances', where designers and users perceptions of affordances may vary.

As Maier et al. (2009) noted "the affordances of the building environment would be different for individuals in different user groups … [and that] affordances may vary for individuals within each user group as well" (p.410).

Boys (2009) raises the perspective of different stakeholders involved in new educational buildings, where the foci of architects, educational theorists, estates managers, teachers and students may vary considerably and that "rather than assuming a common language we need to explore, explicitly debate – and even enjoy – the problematic intersections between these different perspectives" (p. 3). Addressing differences in perceptions, Koutamanis (2006) felt that it was important to correlate the perceptions of different parties involved in a building as "architecture is arguably less successful with the sharp definition of intended functions, presumably because of the complexity of human activities in the built environment" (p.361).

As a means of enhancing dialogue between designers and potential occupants, Tweed (2001) reported on a study using Computer Aided Design (CAD) technologies to attempt to bring greater awareness of user experiences within space by infusing floor plans with human life and activities. He noted, "whilst technically trivial, the utility of merely drawing attention to the presence of different types of users in a design should not be underestimated" (Tweed, 2001, p. 8). More recently, Betsky (2015) discussed how advances in computer visualisation can even enable simulation of movement of individuals or crowds through environments, and by doing so show interactions and influences of people on the experience of space.

Although there are few references in the literature aligning affordances in architecture to socio-cultural contexts, Beek (1994) classified affordances within three dimensions of architecture: organismic-personal; socio-economic; and cultural-aesthetic. The *organismic-personal* level refers to Gibson's foundational understanding of affordances i.e. the relationship between the environment and the user. The *socio-economic* level refers to the interaction between humans in the realisation of common goals and the third level refers to the *cultural-aesthetic* dimensions of architecture. Beek felt that architects needed to design and connect affordances across all three levels and that "architectural flaws are often the result of an emphasis on one level to the neglect of the other levels" (Beek, 1994, p. 34).

Affordances in learning environments

Fisher (2004) noted that "the impact of the physical environment and the rapid changes in information technology and communications on learning has spawned literally hundreds of studies on educational architecture by educational researchers worldwide". However, Gislason (2010) suggested that little of this research has focussed on the intersection of school architecture and educational practice, as generally researchers "consider teaching and learning apart from their architectural setting or study the built environment separately from classroom practice" (p. 127).

Whilst the concept of affordances appears to be a useful tool to bridge the gap between the physical environment with teaching and learning practices, this review of the literature found few references to affordances in relation to learning environments. In contemporary learning environment discourse, reference to the concept has only emerged in the last decade (Alterator, 2018a, 2018b; Alterator & Deed, 2013; Burke, 2014; Cleveland, 2011; Frelin & Grannäs, 2020; Woodman, 2011; Woolner, McCarter, et al., 2012). As the timeline earlier in this chapter shows (see Figure 11), the number of citations for these references are also relatively small compared to other fields.

However, even prior to Gibson coining the term 'affordance' in the late 1970's, the principles behind affordance theory were core to the approach of a few renowned school designers (Hertzberger, 1969, 2008; Medd, 1970; Weinstein, 1979). In his late career book *Space and Learning*, Hertzberger (2008) critiqued practices of architecture where form precedes function. He discussed the opportunity for architects to be more engaged with how space might support better education and the need for design to address a "precision in the conditions they are offering" (Hertzberger, 2008, p. 9). His 1969 article on the Montessori Primary School in Delft specifically addressed the relationship between 'things' and 'people' in relation to architecture:

> The aim of the architecture is then to reach the situation where everyone's identity is optimal, and because user and thing affirm each other, make each other more themselves, the problem is to find the right conditioning for each thing. It is a question of the right articulation, that things and people offer each other. Form makes itself, and that is less a question of invention than of listening well to what person and thing want to be. (Hertzberger, 1969, p. 64)

A decade later, Weinstein (1979) undertook a review of the research in relation to the impact of classroom environments on student behaviour, attitudes and achievement. Six environmental variables were addressed: seating position, classroom design, density, privacy,

noise and the presence or absence of windows. Other sections of the paper included the effects of open spaces and ecological research aligning space with activity. In discussing a requirement for more specificity to environments to support learning behaviours she noted:

> It is time to move beyond appeals for classrooms that are flexible, attractive, and humane. Our eventual goal must be to specify the appropriate physical contexts for various educational activities. (Weinstein, 1979, p. 603)

Aligned with Koutamanis's (2006) view more than thirty years later that the use of an affordance terminology may help transcend stereotypical understandings of space, Medd (1970)[10] advocated for a new approach to vocabulary to define new forms of education. He wrote:

> We have become so used to a particular set of words in schools, that as we utter them, a picture of a finished school automatically comes into our mind…. When we think in these terms, we not only conjure up the character of the spaces but their sizes in our minds. Surely new education should demand new design. (Medd, 1970, p. 178)

Medd went further to state that "the expression and realisation of changing educational needs is doomed unless the architect rids himself of preconceptions of what a school looks like" (Medd, 1970, p. 177). He defined a number of key 'ingredients' of school design which included enclosed spaces, spaces that can be changed, spaces with specialist uses, covered outdoor spaces and outdoor spaces.

Defining learning environment affordances. Terminology used for affordances in learning environments research have varied. Referencing Gibson (1977), Woolner, McCarter, et al. (2012) noted that affordances are "all the 'action possibilities' latent in the environment, objectively measurable and independent of the individual's ability to recognize them, but always in relation to the actor and therefore dependent on their capabilities' (p. 48).

As part of the ILETC project, Imms et al. (2017) referenced both Gibson and Pea in their definition of affordances as "the perceived and actual attributes (Gibson, 1977) and functional properties (Pea, 1993) of an object that could be used to facilitate student learning" (p. 14). This definition raises similar issues to Norman's early interpretation in which the need for affordances to be both perceived and actual is ambiguous, as well as the question of

[10] David Medd and his wife Mary were architects who worked for the UK Ministry of Education from 1949-1972.

whether an affordance can just be perceived but not be real. Perhaps in recognising this, a subsequent ILETC report a year later noted that affordances needed further definition in the context of the project (Mahat, Bradbeer, Byers, et al., 2018).

Villafranca (2020), a member of the ILETC project team defines both affordances and pedagogical affordances for her PhD study on 'curated learning'. She defines affordances "as action possibilities (Hammond 2010; Heft, 1989; McGrenere & Ho, 2000; Turvey, 2012) arising from perceived and actual functional properties of an object (Pea, 1993)" (p. 13), whereas pedagogical affordances are "possible uses of an element of the learning environment to facilitate the learning of another individual" (p. 14).

Referencing Greeno (1994), Alterator and Deed (2013) defined affordances as "aspects of an environment that enable, contribute to, or constrain the kinds of interaction that subsequently occur" (Alterator & Deed, 2013, p. 2). In subsequent papers Alterator (2018a, 2018b) adopted Ramstead et al.'s (2016) definition of natural and conventional affordances, in which conventional affordances relate to practice routines and school level responses.

Although the concept is relatively new to the field of learning environments, similar to other (re)interpretations of Gibson's original conception of affordances, these varying definitions may cause confusion. In addition, as they tend to derive from the field of psychology, they may lack specificity to built environment and education contexts. For the purposes of this study, the author in collaboration with Cleveland and Imms developed a definition for affordances specifically tailored to a learning environments context. The definition for learning environment affordances is "qualities of the environment (space, objects and people) which may be perceived to enable teaching and learning activities and behaviours*"* (Young et al., 2019, p. 5). In addition, it is recognised that the ability for school users to actualise (Heft, 1989) affordances is influenced by a range of external factors including school culture (Gislason, 2010).

This chapter brings perspective to the complexity of learning spaces, beyond the physical characteristics of spaces themselves. It recognises that ILEs are the result of innovative space and innovative practice, involving a multiplicity of influences including how people perceive action possibilities and utilise space. As a product of space and practice, the relational nature of ILEs has resonance to the concept of affordances, a term not yet commonly recognised in fields of architecture and learning environments.

This literature review reveals that limited research exists bridging the design and use of learning spaces. In particular, there are gaps in both research and practice around the use

of ILEs and how to support teachers to transition from traditional classrooms to new types of learning environments designed to support a broader array of pedagogies for deep learning outcomes. This review also indicates that whilst affordances are an appropriate vehicle to explore how to bridge design and use, little research exists around affordances within the field of learning environments. As set out in the research aims discussed in the previous chapter, the focus of this study is to explore the design and use of ILEs through the lens of affordances.

The research design, including methodologies and methods, employed to investigate these question is discussed in the next chapter. Subsequently, the findings associated with each question are presented and discussed in chapters five to seven.

Chapter 3. Research Design

Introduction

In this chapter, I discuss the logic that links the data to be collected and the conclusions to be drawn to the key questions of the study (Rowley, 2002). I have adopted the perspective of Crotty (1998) in structuring four elements of research design: epistemology, theoretical perspective, methodology and methods (see Figure 12). I discuss the data collection and analysis methods used and, later in the chapter, the suitability and limitations of the research approach.

A key objective of this study is to understand *what* learning environment affordances are perceived by those who design and use them. By their very nature, whilst affordances may exist regardless of being perceived (Gibson, 1979), they can only be identified if people perceive them. And, as noted in the previous chapter, being able to perceive and utilise them is influenced by ones' physical and socio-cultural context. Ontologically, this aligns with constructionism (Crotty, 1998; Ormston et al., 2013; Schwandt, 1994). A constructionist perspective is "the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context" (Crotty, 1998, p. 42).

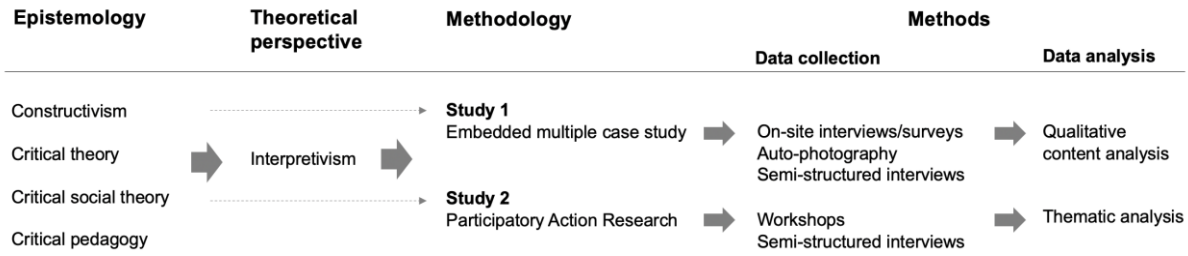
Another objective is to investigate *how* affordances are perceived and utilised by teachers. This aligns with a social constructionist ontological perspective in which the nature of reality (Hudson & Ozanne, 1988) and what there is to know about the world is "produced by exploring and understanding the social world of the people being studied, focusing on their meanings and interpretations" (Ormston et al., 2013, p. 12). Charmaz (2006) describes social constructionism as the reality people create through their individual and collective actions:

> A theoretical perspective that assumes that people create social reality(ies) through individual and collective actions. Rather than seeing the world as given, constructionists ask, how is it accomplished? Thus, instead of assuming realities in an external world – including global structures and local cultures – social constructionists study what people at a particular time and place take as real, how they construct their views and actions, when different constructions arise, whose constructions become taken as definitive, and how that process ensues. (Charmaz, 2006, p. 189)

A social constructionist view focusses on the "collective generation of meaning as shaped by the conventions of language and other social processes" (Schwandt, 1994, p. 127). In the context of my study, this refers to the socio-cultural contexts of schools and how these influence individual and collective understandings of learning environment affordances.

Figure 12

Research Design



Epistemology

The epistemological position for this dissertation is embedded in constructivism, critical theory, critical social theory and critical pedagogy. Constructivism is the epistemological framework which positions how knowledge, or in my study, the phenomena of affordances, is to be captured (Carson et al., 2001). Crotty (1998) notes that constructivism focusses exclusively on "the meaning-making activity of the individual mind" (p. 58), in contrast to the social constructionism view of "collective generation of meaning" (p. 58). As noted above, people's individual perceptions determine their perspectives of affordances, aligning with Schwandt's (1994) position that constructivists are deeply committed to the "view that what we take to be objective knowledge and truth is the result of perspective" (p. 125).

In order to formulate an understanding of affordances, I sought to investigate other people's perceptions of affordances. I recognise that my interpretation of these perspectives is unique and may be different to how other researchers may understand the same perspectives of others. As Crotty notes, constructivism recognises each persons' unique experience, "it suggests that each one's way of making sense of the world is as valid and worthy of respect as any other" (Crotty, 1998, p. 58). In discussing how people, including researchers, construct the realities in which they participate Charmaz (2006) notes:

> Constructivist inquiry starts with the experience and asks how members construct it. To the best of their ability, constructivists enter the phenomenon, gain multiple views of it, and locate it in its web of connections and constraints. Constructivists acknowledge that their interpretation of the studied phenomenon is itself a construction. (Charmaz, 2006, p. 187)

In order to make sense of affordances, I needed to interpret this phenomenon through the multiple perspectives of others who interface with them.

Critical theory. In contrast to theory focussed merely on analysing society, the focus of critical theory is to empower people to overcome the social circumstances that constrain them (Ormston et al., 2013). Critical social science was developed by the Frankfurt School, an interdisciplinary group of social theorists in Germany who initially collaborated between 1924 to 1933. In exposing injustices and power imbalances, critical theory draws upon neo-Marxism and subsequently feminism, social models of disability, critical race theory, and 'queer theory' (Ormston et al., 2013, p. 16). The aim of critical theory is not just to reflect on the current context to understand the underpinnings of life, but to challenge, seek change, and improve the quality of human life (Crotty, 1998; Zeegers & Barron, 2015). Rather than purely focussing on facts that mirror society, or theory which is distinct from the lived reality of social life, referencing Horkheimer (1937), Crotty (1998) notes that critical theory involves "philosophy and science informing each other in dialectical fashion" (p. 131). Critical theory has influenced alternate ways of thinking about 'researcher' and 'research participants', toward greater equality and more collaborative research processes.

Critical social theory. Further informing the design of the study is critical social theory, a theory founded by Habermas (Habermas, 1971, 1973, 1989) which promotes the critique of social settings with the intention of facilitating social change by social actors. Knowledge derived through critical social theory emanates from periods of change and is what Lather (1986) describes as 'research as praxis', referring to an interactive shaping of theory and practice central to emancipatory social science. It offers a methodological approach as described by Neuman (2003) as being between a positivist (more objective) and interpretivist (more subjective) approach, and one which "seeks to provide people with a resource that will help them understand and change the world" (p. 85).

Lather notes:

> Emancipatory knowledge increases awareness of the contradictions hidden or distorted by everyday understandings, and in doing so it directs attention to the possibilities for social transformation inherent in the present configuration of social processes. (p. 259)

Through self-reflection and deeper readings of their contexts, praxis-oriented research enables participants to change.

Critical pedagogy. Critical social theory has been influential in the context of education and schools, and prominent in the work of educational theorists such as Dewey (1940, 1963) and Freire (1970, 1973). Freire's work involved bringing literacy programs to educate the peasant peoples of north-east Brazil. The methodology used in these programs was not a top down approach of teaching 'to' the people, but one in which teachers engaged with communities to understand the contexts where they lived, to be able to develop an education 'with' the people to ensure it would be meaningful and empowering for them. Through Freire, the term 'conscientisation' was popularised which refers to an awakening, or an increase in consciousness (Crotty, 1998) aligned to the relationship between humans and their world. Freire noted: "we are not only 'in' the world, but also 'with' the world" (Crotty, 1998, p. 149).

In my research, critical theory, critical social theory and critical pedagogy offer a suitable lens through which to undertake research 'with' rather than 'for' or 'on' participants in order to support them to explore and enable change. The framing of the study assumes that teachers are likely to be familiar with traditional classrooms, and therefore in the context of new ILEs, need to transition their practice from one type of environment (traditional spaces) to another (ILEs). To investigate the change that occurs in this transition requires an understanding of the lived reality of teachers and the influences around them as they experience different physical environments as part of their practice.

As ILE's are designed to enable more collaborative modes of teaching and learning, it is necessary to not just consider individual teacher's experiences, but also the collective of teachers who will work together to use these new spaces. The iterative nature of a praxis-oriented research process provides opportunities for repeated dialogue between participants as well as researcher and participants to bring greater consciousness to the relationship between environment, users and resulting action possibilities. Through collective reflection,

social circumstances in which teachers currently practice and how this might enable or constrain the actualisation of new affordances will become more apparent.

In informing my research questions relating to practice change in educational contexts, these epistemologies focus on transforming, rather than merely attempting to explain or understand moments in the transformative process (Carr & Kemmis, 1986).

Methodological perspective

An interpretivist perspective informed my methodology. The interpretivist view that reality is multiple and relative (Hudson & Ozanne, 1988) aligns with constructivist epistemology where individuals construct (similar or different) realities in which they participate. Motives, meanings, reasons and other subjective experiences which are time and context bound (Hudson & Ozanne, 1988; Neuman, 2003) are critical to interpretivist researchers. In attempting to capture the complexity of meanings in human interaction, interpretivists avoid rigid structural frameworks commonly associated with positivist research and adopt more personal and flexible research structures (Carson et al., 2001). In interpretivism, the relationship between researcher and participants is interdependent and mutually interactive (Hudson & Ozanne, 1988). Referencing Hudson and Ozanne (1988), Don-Solomon and Eke (2018) note that this collaborative research approach is consistent with the interpretivist belief that humans have the ability to adapt, and that no one can gain prior knowledge of time and context bound social realities. Carson et al. (2001) suggest that knowledge acquired in interpretivism is socially constructed rather than objectively determined.

Affordances exist and are recognised within a socio-cultural framework, hence the interpretivist perspective is well suited to my research in looking at the varied and different perspectives of individuals within their unique contexts. The nature of learning, and the socialisation of affordances within a form-of-life suggests that teachers are able to individually and collectively adapt their practices in order to shape their understandings to pick up more affordances. This investigation into *how* to support teachers in actualising affordances also aligns with the interpretivist belief that humans are able to adapt (Hudson & Ozanne, 1988).

As noted in the previous chapter, there is little theory or research that exists about learning environment affordances. Therefore, my study was largely based on an inductive process, in which knowledge was generated from observations and insights taken from the

research participants who inhabited the world of schools. However, there is no doubt that my experience as an architect working in education/learning spaces design, and my participation as part of the Innovative Learning Environments and Teacher Change (ILETC) project, influenced the questions that were asked, and my interpretation of the data collected. As Blaikie (2007) argues, there is no such thing as 'pure' induction or 'pure' deduction. Furthermore, Ormston et al. (2013) noted that inductive researchers do not necessarily approach their data with a blank mind, that is, "the questions they have asked and the analytical categories they have employed will have been influenced by assumptions deductively derived from previous work in their field" (p. 6).

Prior to beginning my research, my primary role was as an architect regularly interfacing with educators in the design of schools. This gave me prior knowledge about the types of spaces that could be included in the design of new learning spaces. However, through the many interviews and discussions with teacher participants as part of this study, I have gained a much richer and deeper understanding of the potential action possibilities offered by the environmental qualities of school spaces, and the challenges for teachers and their students in encountering new spatial typologies. Interviews with other architects have also helped me reflect on my own understandings and to see how others consider the nexus of space and learning activities.

Methodology and methods

I'll now discuss the rationale behind the research methods (the methodology), and the choice and use of particular methods and link these to the specific issues raised in the research questions. Qualitative research takes the perspectives and accounts of research participants as a starting point (Ormston et al., 2013) and is often described as a naturalistic, interpretative approach, concerned with exploring phenomena 'from the interior' (Flick, 2009). It studies things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2011, p. 3).

In exploring people's perceptions of affordances, my research responds to 'what' and 'how' questions which methodologically point toward a qualitative study (Flick, 2009; Ormston et al., 2013; Vaismoradi et al., 2014). To identify which affordances are perceived, it was important to situate my research within physical settings so that both educator and architect participants could see, hear, feel and comment on the same environments. It was also important that the research took place in the 'natural settings' of the schools where

educators worked in order to explore how contextual elements such as school policies, spaces, objects, other teachers and students influenced their experiences of trialling new practices.

The nature of the 'what' and 'how' research questions needed to be addressed in different ways, and in sequential order as responses to each question helped inform the next. The study was designed as an iterative mixed method design, where activity from one phase steered and determined the approach for the next. This was required because basic knowledge needed to be determined about affordances, before strategies to help actualise them could be designed and tested. The study was designed as two distinct stages: the first study based on a case study methodology (Stake, 1995; Yin, 2014), and the second on a Participatory Action Research (PAR) methodology (Kemmis et al., 2014).

Field work for the first study took place in November and December of 2017. The second study took place across two stages, the first from August to December 2018 and the second stage in August and September of 2019. In the next part of this chapter I further discuss the methodologies and methods in relation to each study.

Study 1: Case study: Do you see what I see?

Methodology

The initial phase of this study focussed on developing an understanding of the affordances that architects and educators saw in different types of learning environments. Using Gibson's (1979) affordance theory as a methodological tool, the objective was to gain insights into the types of affordances people perceived in learning spaces and to develop a taxonomy of learning environment affordances that may be used to direct subsequent phases in this study.

The initial research questions sought to understand 'what' the affordances of learning environments are and 'how' these are perceived by architects and educators. The case study methodology was selected as an approach that supports deeper and more detailed investigations into complex social phenomena (Yin, 2014). Case studies are used to examine phenomena within their real-world contexts and can be particularly helpful when the boundaries between phenomena and context are not clearly evident (Rowley, 2002; Yin, 2014). In the case of this study the context is 'learning environments' with the phenomena being investigated representing the 'affordances' that the environment comprises.

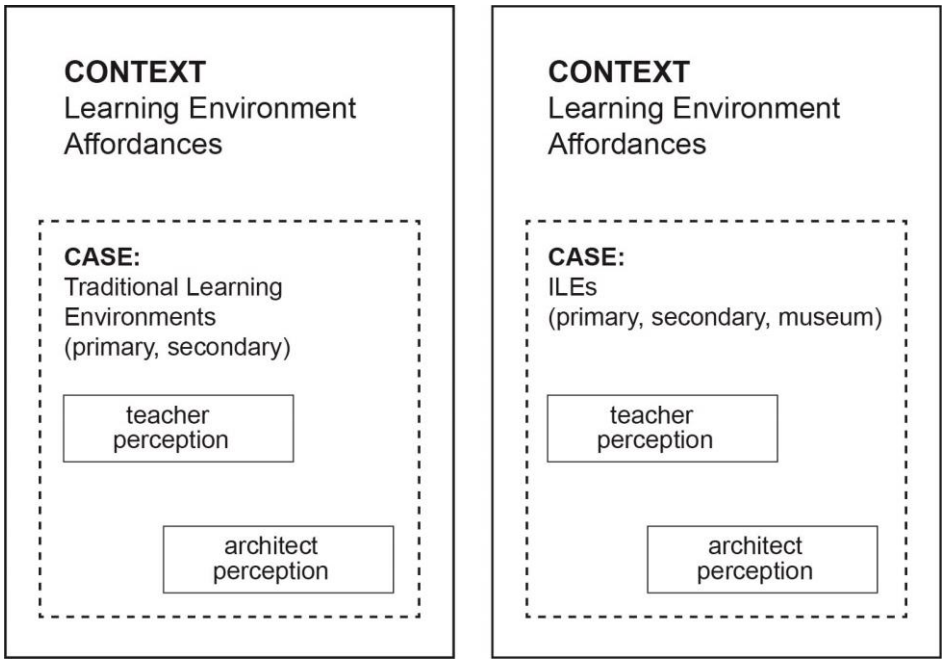
My study is based on a multiple (Yin, 2014) or collective (Stake, 1995) case study which allows the researcher to analyse similarities and differences both within and across settings (Baxter & Jack, 2008). Each individual case however, is instrumental (Stake, 1995) and used to provide insights into an issue and therefore to accomplish something other than understand a particular situation. These have been looked at in depth in order to help pursue the external interest (Stake, 1995) of affordances.

The framing of my case study has been based on Yin's (2014) embedded multiple case study (p. 50), which includes a context, a case, and embedded units of analysis. These aspects have similarity to Thomas's (2011) case study definitions of object (or analytical frame), subject, and unit of analysis. In my study, the context (object, or analytical frame) is learning environment affordances. The subject of the study, or case, is the learning environment, and the units of analysis are architects and teachers. The components of my study are shown in Figure 13:

- Context/object/analytical frame: learning environment affordances.
- Case/subject: traditional learning environments and ILEs (including primary, secondary and museum learning environments).
- Units of analysis: teachers' and architects' perceptions.

Figure 13

Embedded multiple case study



Note: Adapted from Yin (2014).

Sampling

In seeking to understand a breadth of perspectives of affordances across a range of typologies, case studies were selected in both traditional and ILE spaces at both primary and secondary schools. A dedicated learning space within a museum was also included in order to gauge if affordances in a non-school context varied from those observed in schools, potentially extending the breadth of a resulting affordance taxonomy.

As this study was situated in deep learning, school case studies were selected that demonstrated a commitment to more diverse pedagogical practices including collaborative and interdisciplinary learning. These are some of the capabilities that align with 21st Century skills and deep learning concepts. As noted in the previous chapter, as part of the ILETC project, Imms, Mahat, Byers and Murphy (2017) undertook a survey of 822 schools across Australia and New Zealand to determine baseline conditions of space typologies and teaching approaches. Data from the initial Innovative Learning Environments and Teacher Change (ILETC) survey (Imms et al., 2017) was purposefully sampled to select four schools – two from primary level and two from secondary. All four of these schools were rated as being high in collaborative learning and team teaching (associated in the previous chapter as an enabler of interdisciplinary learning). Schools were selected to provide representation across Dovey and Fisher's (2014) typologies of learning spaces (A–E) (refer Figure 9, Chapter 2). Types A and B are more reflective of traditional classroom spaces, types D and E of ILEs, and type C spaces represent a 'middle ground' that reflect traditional combined with some ILE configurations.

The process for purposefully selecting school sites is shown in Figure 14. Of the 822 schools that responded to the survey, 508 were full primary and contributing[11] schools and 230 were secondary schools (Imms et al., 2017). The remaining schools were noted as intermediate, combined (or composite), special schools or other. Survey data reflected six pedagogical typologies: teacher facilitated large group, teacher facilitated small group, team teaching, collaborative learning, one-on-one instruction and individual learning. In each of these categories, a percentage reflected the relative proportion devoted to each teaching and learning approach at each school.

[11] Of the 508 schools noted, 399 were primary schools and 109 were contributing schools. The majority of New Zealand primary schools are contributing schools (for students aged from five to 10). Following primary school, students attend intermediate school for two years prior to secondary school.

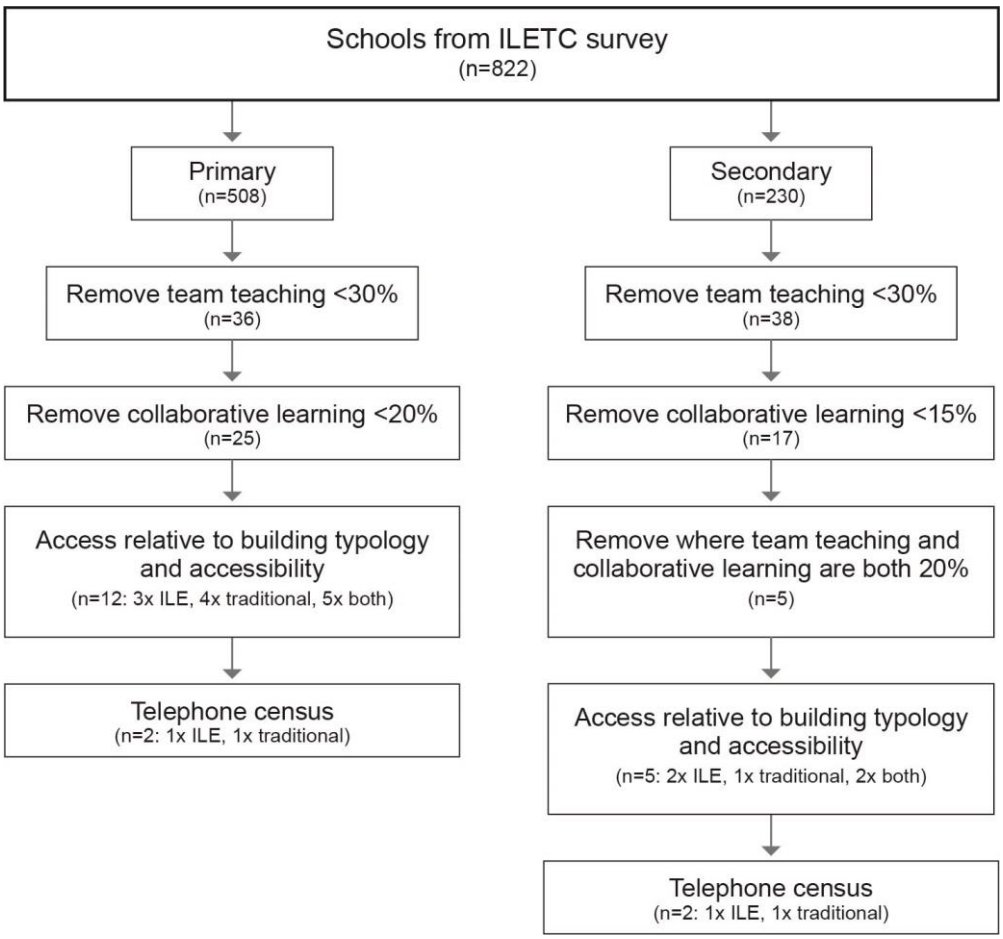
Data was initially filtered to focus on schools that were most representative of high levels of ‘collaborative learning’ and ‘team teaching’ at either primary (and contributing) or secondary school. Percentages ranged from 0-86% for team teaching and 0-60% for collaborative learning. For the primary/contributing schools, all schools with less than 30% team teaching were removed leaving 36 schools in total. Next, any with less than 20% collaborative learning were removed (except for two that had an exceptionally high percentage of team teaching), leaving 25 schools. The remaining schools were then assessed relative to their representative building typology and accessibility. 12 primary schools were identified for contacting as part of a telephone census. Three of these schools had 100% ILE spaces, four were predominantly traditional schools and five had a mixture of both types of spaces.

At secondary level, all schools with less than 20% team teaching were initially removed leaving 38 schools. Next, all schools with less than 15% collaborative learning were removed leaving 17 schools. Of the remaining schools any that had the lowest percentage of 20% for both categories of team teaching, and collaborative learning were removed leaving nine. These schools were then assessed relative to their building typology (A-E) with five identified for contacting as part of a telephone census. Two of these schools had 100% ILE spaces, one was 100% traditional and two were a mixture of both.

Contacts for identified schools were sought and when possible, Principals from identified schools were contacted to clarify if their schools engaged in cross-disciplinary programs or teaching approaches, and whether these programs operated in traditional or ILE spaces. Figure 14 below shows the sampling process undertaken.

Figure 14

Methodology for sampling school case study sites



The selected museum had a learning space custom-designed to support interdisciplinary STEAM (Science, Technology, Engineering, Arts and Maths) programs offered to visiting primary and secondary school students (as well as other learners). Further to this, all programs were team taught with a strong focus on student collaborative learning.

Case study sites

Table 4 shows the range of case study sites and how they reflect Dovey and Fisher's (2014) typologies. Whilst a site with type A spaces was not included in the sample, Site 1 was representative of the traditional self-contained classroom typology. A description of the sites follows.

Table 4

Case study sites

	Primary	**Secondary**	**Museum**
Traditional	**Site 1** Type B	**Site 2** Type C	
ILE	**Site 3** Type C	**Site 4** Type E	**Site 5** Similar to Type D

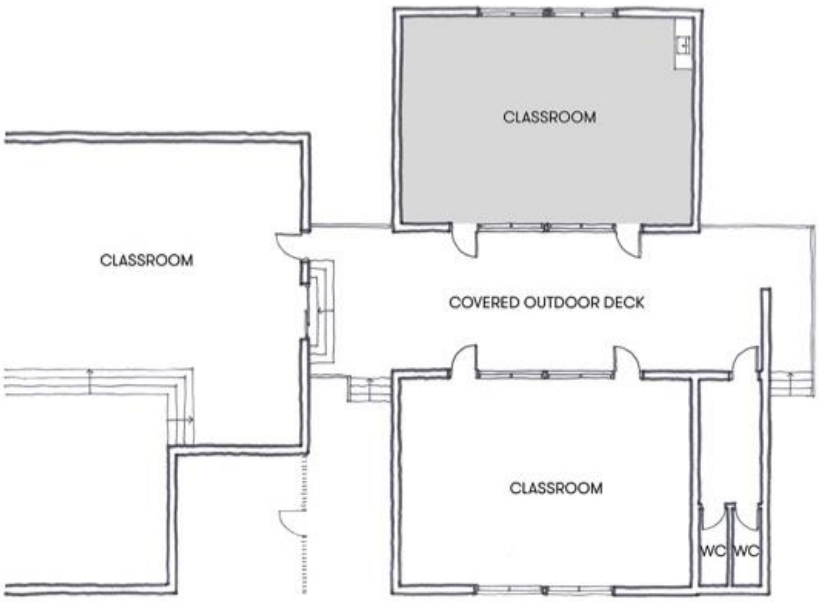
Site 1 **(primary school learning space).** Site 1 is a co-educational primary school in New Zealand. At the time of the study, there were approximately 320 students located within 13 temporary demountables and a library space converted to a large classroom. A new ILE building was about to be constructed, although due to procurement delays the school had many years to prepare teachers for more collaborative practices.

There was a strong culture of teacher collaboration at this school and significant work had been done around the school's pedagogy to support the move toward an ILE. At this school, students addressed teachers on a first name basis. Students were also encouraged to move furniture around classrooms to suit their learning needs. Whilst the learning spaces were effectively cellular classrooms, there was a fluidity across individual classrooms by both teachers and students. This was facilitated by the configuration of classrooms, with groups of three demountable classrooms clustered around a central shared outdoor deck.

The study took place in a shared Year 3 and 4 demountable classroom (refer Figures 15 -17). The room itself had two entry doors, one at either end of the room, with a whiteboard and interactive whiteboard at one end, and a wet area with sink at the other. The majority of the room was carpeted, with a linoleum floor at the wet area end of the room. Furniture predominantly comprised individual metal framed timber top desks and stackable polypropylene chairs in varying configurations around the room with a larger shared table located at the wet area. Resources were located in open shelving around the room.

Figure 15

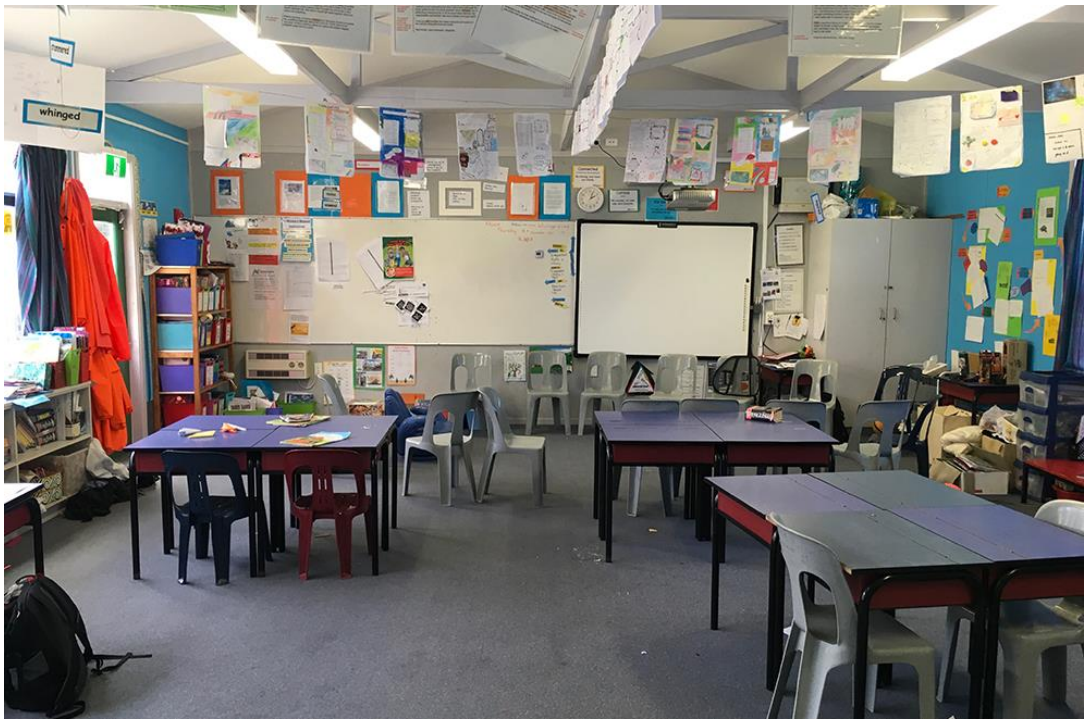
Plan diagram of Site 1



Note: From Young et al. (2019, p. 699)

Figure 16

Site 1 classroom



Note: From Young et al. (2019, p. 700).

Figure 17

Shared timber deck outside Site 1

Note: From Young et al. (2019, p. 700).

Site 2 **(secondary school learning space).** Site 2 is co-educational secondary school in Western Sydney. Following a period of low staff morale, poor community perception and declining enrolments, a new principal arrived in 2010 to lead a transformation process that empowered staff with shared purpose in shaping the school's future. When this study was undertaken in 2017 there were 600 students with a waitlist to get into the school. As a result of the transformation, the school was recognised in 2017 by *The Educator Online* as one of the top 40 schools in Australia demonstrating leadership in change and innovation.

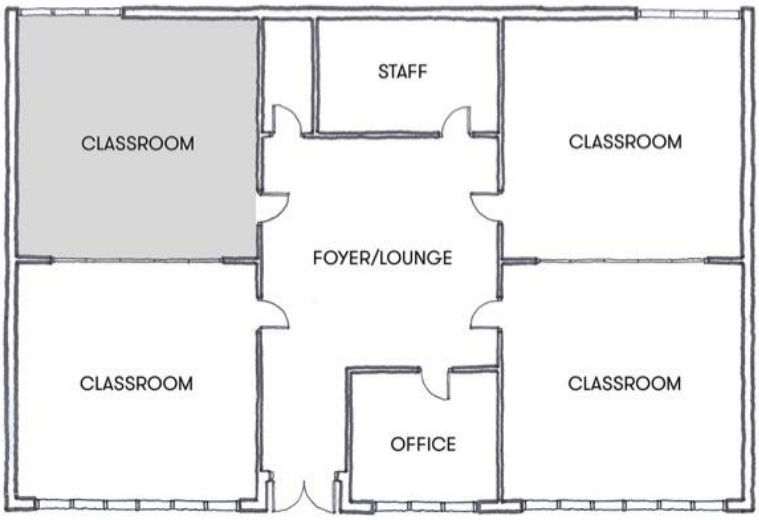
The school facilities had been developed in 1981 as part of a complex comprising a high school, a primary school and special purpose school. The facilities include combined school/community facilities: a library, gymnasium, hall and playing fields. Thirty percent of the school is traditional in nature (types A and B) and 60% is type C (Dovey & Fisher, 2014). The remaining 10% reflects the use of the school library as a more open learning space.

The study took place in a Middle School (Year 7) classroom which comprised one of four classrooms arranged around a shared foyer/lounge space. The classrooms were paired, with a retractable wall between. However, it should be noted that in both paired classrooms retractable walls were permanently closed (refer Figures 18-20). Furniture was predominantly

two-seater tables and polypropylene chairs laid out in a U-shape facing the front, with some extra desks in the centre of the U.

Figure 18

Plan diagram of Site 2



Note: From Young et al. (2019, p. 701).

Figure 19

Site 2 classroom

Note: From Young et al. (2019, p. 701).

Figure 20

Site 2 foyer/lounge with classroom beyond

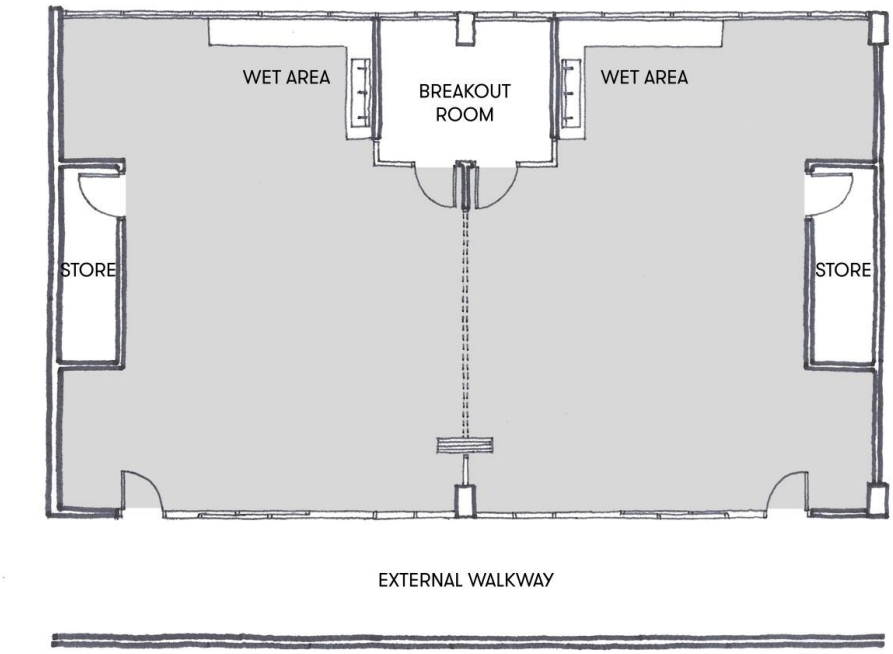
Note: From Young et al. (2019, p. 702).

Site 3 **(primary school learning space).** Site 3 is a new co-educational primary school in Sydney that opened in 2016. At the time of the study, there were 300 students, however the school is built to accommodate up to 1000 students. Survey data indicated that the school comprises 100% type D spaces, however the paired classroom model prevalent throughout the school is more aligned to type C (in which a retractable wall separating two classrooms is permanently open). Each paired classroom has a variety of learning settings (somewhat reflective of type D spaces). Teachers and students have a shared language which defines how different settings best accommodate different types of learning activities, and students are encouraged to either move furniture or move themselves to settings which suit tasks they are undertaking.

The study took place in one of the paired classrooms with an opened retractable wall, a small breakout room, well-defined wet areas and a glazed wall to a shared walkway (refer Figures 21-23). A diverse range of furniture included moveable tables of varied shapes, a range of seating options for both individuals and groups, and integrated storage options.

Figure 21

Plan diagram of Site 3



Note: From Young et al. (2019, p. 703).

Figure 22

Site 3 view towards walkway

Note: From Young et al. (2019, p. 704).

Figure 23

Site 3 view towards breakout room

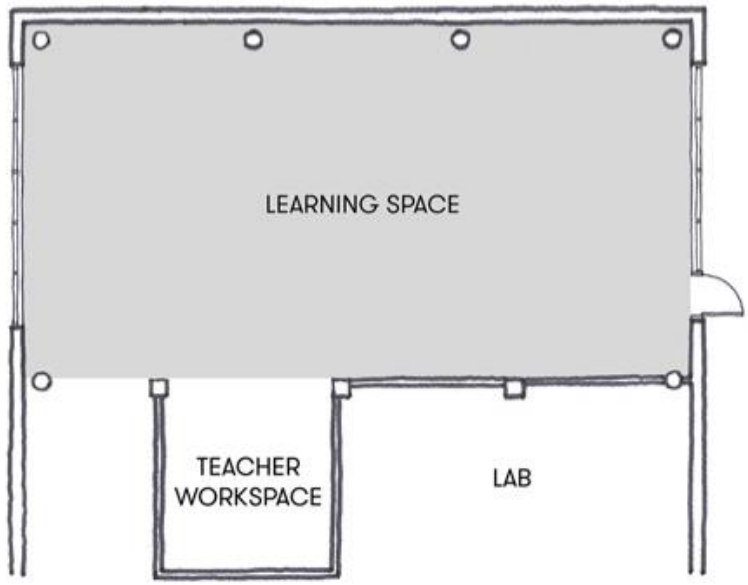
Note: From Young et al. (2019, p. 704).

Site 4 **(secondary school learning space).** Site 4 is a South Australian co-educational school for year 10-12 students with a strong focus on interdisciplinary learning programs, the development of STEM (Science, Technology, Engineering and Maths) skills and collaborative learning. At the time of the study, there were 370 students at the school. The school is designed around an extended "learning commons" comprising five commons, three studios, four teacher preparation areas and a student lounge. There is a high level of transparency throughout the school with spaces either completely open, or separated by glass partitions, promoting openness, visual continuity and collaboration (Oliver & Fisher, 2015). Students have high levels of autonomy in how and where they work and are able to access a range of different teachers to facilitate their learning.

The study was conducted within a Year 12 learning space which was large, open and with high ceiling heights. It was approximately the size of two typical classrooms (refer Figures 24-26). This space was connected to a teachers' workspace and laboratory and comprised a range of moveable tables and varied seating options of different heights and styles.

Figure 24

Plan diagram of Site 4



Note: From Young et al. (2019, p. 705).

Figure 25

Site 4 learning space

Note: From Young et al. (2019, p. 706).

Figure 26

Site 4 view towards teachers' workspace and laboratory (beyond glazing)

Note: From Young et al. (2019, p. 706).

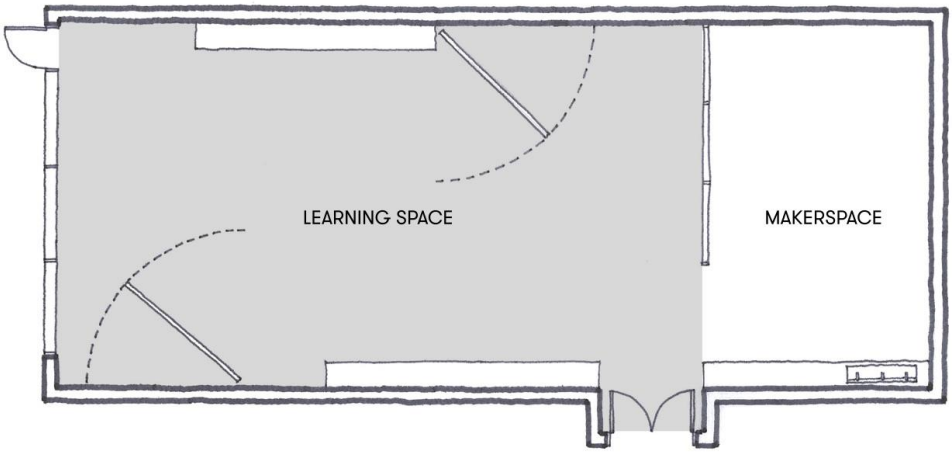
Site 5 **(museum learning space).** Site 5 is in a dedicated learning space within a museum. It was refurbished in 2017 just prior to the study taking place. Learning programs at Site 5 are based on a STEAM (Science, Technology, Engineering, Arts and Maths) approach developed to support learners to make interdisciplinary connections. Programs are inspired by the museum's collection and specifically designed in consideration of the development of 21st century skills for learners from early childhood, to primary and secondary. At the beginning of every session students are welcomed to the learning space and given permission move furniture or use other aspects of the space as required, encouraging a sense of ownership.

The space was approximately the size of two classrooms with a separated 'maker space' containing a wet area and other zones defined by technology resources such as virtual reality equipment, digital touch tables, and 3D printers (refer Figures 27-29). There was little furniture within the space, however of what existed, all was mobile (on wheels or on glides). There was a large amount of storage containing learning resources which were easily

accessible to students. Some resources were housed in mobile trolleys which could be moved around the room.

Figure 27

Plan diagram of Site 5



Note: From Young et al. (2019, p. 707).

Figure 28

Site 5 learning space

Note: From Young et al. (2019, p. 707).

Figure 29

Site 5 view towards Maker space

Note: From Young et al. (2019, p. 708).

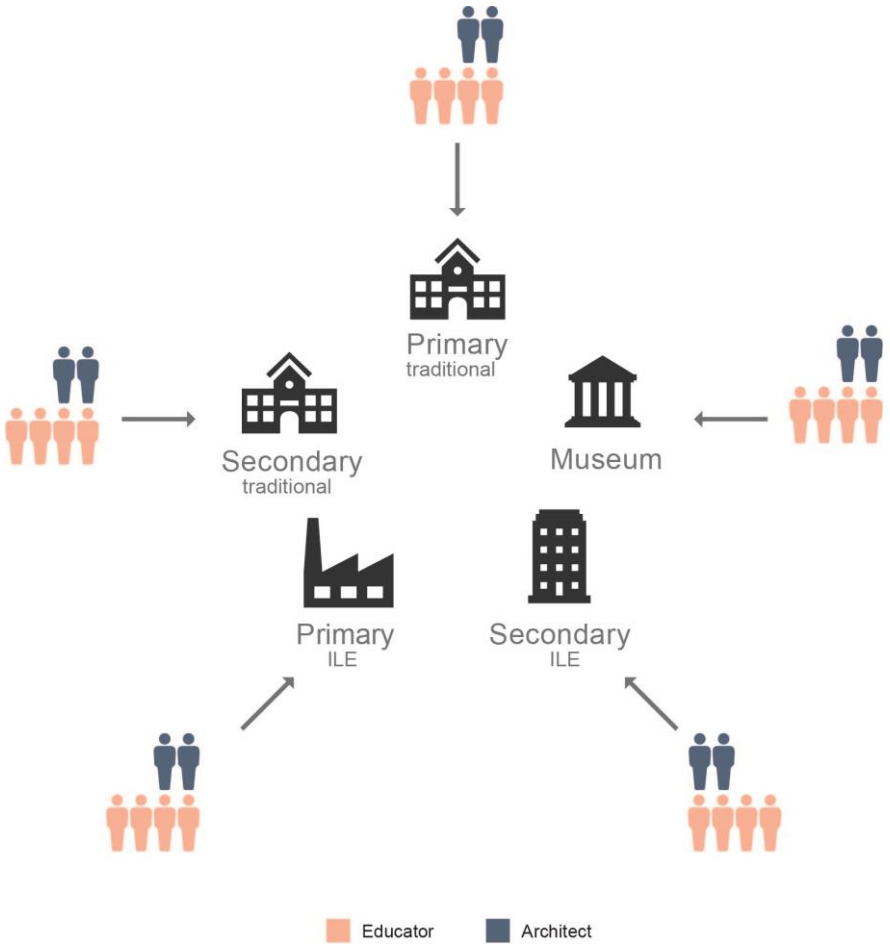
Participant selection

Four teachers and two architects participated at each of the five sites (refer Figure 30). Teachers were selected in consultation with school principals to reflect three different career stages as follows (Table 5):

- Early stage teacher (0-2 years)
- Mid-stage teacher (2-7 years)
- Established teacher (7+ years)

Figure 30

Study 1 case studies



At Site 5 (the museum learning space) there were only two teachers who fulfilled these criteria, hence I was assisted by representatives of the New Zealand chapter of Learning Environments Australasia (a professional network association) to source two additional teachers from local schools to participate in the study.

To ensure that Architects with adequate experience and understanding in learning space design were recruited for the study, selection criteria included five or more years of experience working on primary and secondary school building projects. Other desirable selection criteria included:

- Involvement in the design of the learning spaces at the case study site (only relevant to ILE sites 3-5)
- Membership of Learning Environments Australasia (a4le.org.au)

Table 5

Study 1 participants

Participants		Site 1	Site 2	Site 3	Site 4	Site 5
Teachers	**Early stage** (0-2 years)		1	1		1
	Mid-stage (2-7 years)	2	1	1	3	2
	Established (7+ years)	2	2	2	1	1
	Total no. of teachers/site	4	4	4	4	4
Architects	**Involved in design of case study**			1	1	1
	Not involved in design of case study	2	2	1	1	1
	Total no. of architects/site	2	2	2	2	2

Methods

I will now discuss the methods for data collection and data analysis used to address the research questions associated with Study 1 (Table 6).

Table 6

Data collection and analysis

Research question	Participant	Data collection	Data analysis
What are learning environment affordances?	Educators Architects	On-site semi-structured interviews Auto-photography	Content analysis
How are the affordances of ILEs perceived?	Educators	Semi-structured interviews	Thematic analysis

Data collection

Field work at the case studies took place in November and December of 2017. At each site, the educators and architects were invited to participate in an individual interview. These were conducted within the chosen learning spaces (profiled above) whilst unoccupied by students. This ensured consistency so that all participants experienced the same spaces in the same way. Initially, participants were asked to describe:

a) how the space *enabled* learning activities and
b) how the space *constrained* learning activities.

Data was also collected via auto-photography (Glaw et al., 2017; Thomas, 2009). This is an ethnographic field research method where research subjects are given cameras to photograph aspects relevant to the research topic, and by doing so, we attempt to 'see the world through someone else's eyes' (Thomas, 2009, p. 1). The photographs become data as part of the study and may become part of a Photo Elicitation discussion between researcher and participant.

At the beginning of each on-site interview session, participants were given an iPad to photograph the spatial features they perceived to afford pedagogical activities. Having two different sources of input enabled data to be triangulated to enhance data quality and confirmation of findings (Baxter & Jack, 2008; Morse, 1991). Subsequently, participants were asked whether any of the features they described specifically supported the following approaches to teaching and learning:

- deep learning
- collaborative learning
- team teaching
- interdisciplinary learning

Following the on-site interview, semi-structured interviews were conducted with participants in person, otherwise if this was not possible, via telephone. Participants were shown a list of affordances that they had identified in the on-site interview and asked if there were any additional affordances that they felt could support deep learning that they had not mentioned earlier. They were also asked whether they felt there was a hierarchy of affordances that enabled or constrained deep learning. In addition, teachers were also asked

to identify ways in which they had previously learnt to recognise and use new affordances as part of their practice. The interview questions are outlined in Table 7.

Table 7

Study 1 interview questions

On-site interview questions	
1	How can this space be used for learning activities?
2	Of the aspects you described, which do you think best support student deep learning?
3	Of the aspects you described, which do you think best support collaborative learning activities?
4	How do you think this space supports team teaching?
5	How do you think this space supports interdisciplinary learning?
6	How do you think this space constrains learning activities?
Semi-structured interview questions	
1	Can you think of any other elements of the physical environment (either at this school or elsewhere) that you didn't see (or mention) in our on-site observation which you think also support student deep learning?
2	Would you consider there to be a hierarchy of importance of these elements in enabling or constraining student deep learning?
3	(Teacher participants only) What have been the most effective ways for you to learn to recognise and use the types of features not typically seen in traditional learning spaces?

Data analysis

Data was analysed through content analysis and thematic analysis. These approaches are largely based on the "factist" perspective which assumes that data is assumed to be more or less accurate and truthful indexes of the reality out there (Sandelowski, 2009; Vaismoradi et al., 2014). In other words, the researcher wants to find out about the actual behaviour, attitudes, or real motives of the people being studied, or to detect what has happened (Have, 2004). These data analysis approaches share similarities with grounded theory (Charmaz,

2006; Glaser & Strauss, 1967) in that they both involve systematic coding processes, however in the case of content analysis and thematic analysis, data collection and analysis takes place sequentially rather than in parallel.

Addressing the query as to 'what' affordances might be perceived by an architect as opposed to an educator requires comparing participants perceptions across professions. This was conducted through content analysis. This method of analysis is used to determine common patterns in data by searching for and then using a consistent set of codes to organize text with similar content (Cho & Lee, 2014). Content analysis is 'the systematic qualitative and quantitative analysis of the contents of a data corpus' (documents, texts etc) (Saldaña, 2016, p. 300). This method classifies data into identified categories of similar meanings (Moretti et al., 2011). Its value in responding to the "what" question in relation to learning environment affordances, is the use of a descriptive approach in coding the data as well as quantitative counts of the codes (Downe-Wamboldt, 1992; Morgan, 1993). Therefore, it is possible to analyse data both qualitatively and at the same time quantitatively (Grbich, 2007) supporting the goal of identifying a taxonomy of affordances as well as a comparative exercise in seeing different professions' perceptions.

Thematic analysis was used to analyse data in relation to understanding 'how' affordances are perceived. It is less about a categorisation of 'typology' and requires a more detailed and nuanced account of data. It is similar to content analysis, in which an inductive approach is used, and where codes, categories, or themes are directly drawn from the data (Cho & Lee, 2014), however it provides a purely qualitative, detailed, and nuanced account (Braun & Clarke, 2006).

Example of the coding and analysis process

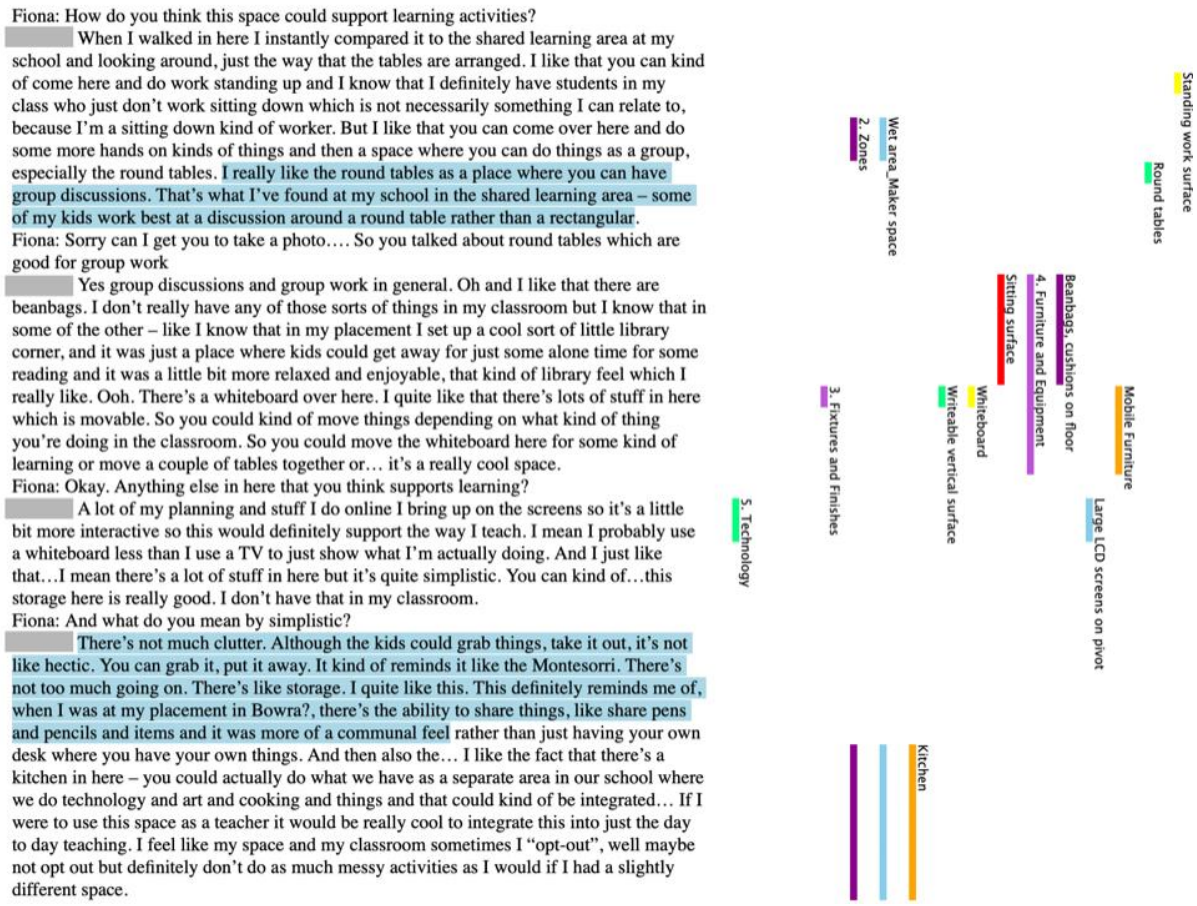
Audio recordings from the on-site interviews and semi-structured follow-up interviews were transcribed and coded using *NVivo* software. Transcriptions were read, and 'nodes' created by selecting and labelling of text relating to varying themes. Reoccurrence of similar themes were categorised using the same node. Statements of particular interest were also identified and highlighted in the text and labelled.

Figure 31 shows an example of a coded interview. The name of the interviewee is blanked out in grey and comments of interest highlighted in blue. Identified nodes are shown on the right-hand side of the image. Each of the 'coding stripes' reflects the extent of selected text representing each node. Coding stripes on the same line reflect a reoccurring node, for

example, ‘wet area_maker space’ and ‘zones’ have been identified twice in this passage of text. Some portions of the text reflect multiple nodes, for instance the comment “I like the fact that there’s a kitchen in here – you could actually do what we have as a separate area in our school where we do technology and art and cooking and things and that could kind of be integrated” has been coded to ‘kitchen’, ‘wet area_maker space’ and ‘zones’. This process of coding was completed for each case prior to analysis across cases (Stake, 1995).

Figure 31

Example of coded transcript using NVivo software

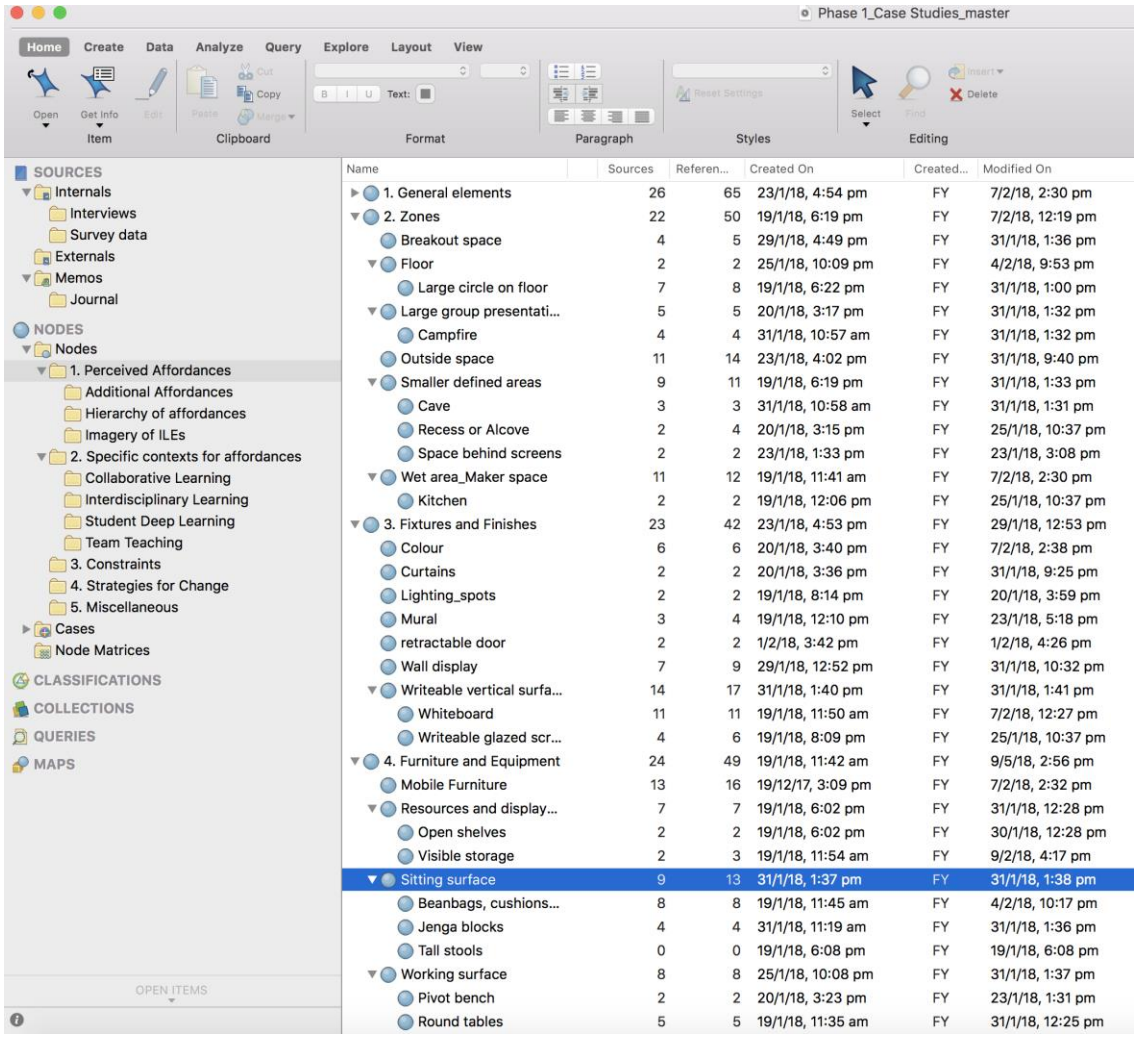


Cross-case analysis (Stake, 1995) took place after each case was analysed separately. After all individual interviews were coded, the nodes across all cases were reviewed and regrouped into overarching themes. For example, Figure 32 shows how initial coding was tabulated across all the transcripts as a hierarchy of nodes and sub-nodes. In this example, nodes of ‘cave’, ‘recess or alcove’ and ‘space behind screens’ was consolidated into a parent node called ‘smaller defined areas’. This node was a sub-set of ‘Zones’ which in turn was a subset of ‘perceived affordances’. Through cross-case analysis, general themes relating to the

affordance phenomena were produced. These were then compiled into a taxonomy of affordances which will be discussed in the next chapter (see Categories of learning environment affordances).

Figure 32

Example of theme definition



Similarly, themes relating to deep learning, collaborative learning, interdisciplinary learning and team teaching were synthesised via the NVivo software (refer Figure 32). Data from NVivo was transferred to Excel to clarify which affordances were identified, and the number of times they occurred in participant interviews relative to the different teaching and learning approaches, and whether responses were from educators or architects. Participant responses relating to the most important affordances or the most constraining were also analysed. Once this data was compiled, it was synthesised from most

rated (=1) to least rated (between 2 to 6) (refer Figure 33). Data from the auto-photography component of the study were similarly coded. Images taken by each participant were sorted into themes and tabulated to determine commonalities within and across sites (see Appendix G).

This model building process produced three outputs (1) identification of a list of participant identified affordances (see Chapter 4, Categories of learning environment affordances), (2) a taxonomy of affordances relative to teaching and learning approaches (see Chapter 4, Affordances relative to teaching and learning approaches), and (3) a list of strategies used to support teachers in using affordances of new learning spaces (see Chapter 5).

Figure 33

Example of quantitative tally of theme occurrence

Primary Spatial Properties	Affords	Features	Student Deep Learning		Collaborative Learning		Interdisciplinary Learning		Team Teaching		General Hierarchy		Constraints	
			Educator	Architect	Educator	Architect	Educator	Architect	Educator	Architect	Educator	Architect	Educator	Architect
General														
A range of different settings	Different ways for students to work	Zones, seating, tables, booths, breakout areas, wet areas, makerspaces, floor	1=	1=	1=	1=	2=	2=	2	3		2=		5=
Places where groups can get together	Ability to collaborate	Circular tables, booths, floor	1=	2=							1			
Spaces that can be changed/used in different ways	Ability to change space/practice	Multi-use and flexible spaces defined through mobile furniture or joinery, moveable walls or doors					2=	2=			2=	2=		
Larger (than traditional) learning spaces	Ability for more teachers and students (than in a typical class size) to work together	(At least) twice as large as a traditional classroom (to allow a minimum of two classes to learn together)					4=	1=	1	2	3=		1	1
Spaces that can be used in different ways	Ability to co-locate and merge learning activities	Agile spaces with more than one function					2=	2=						
Centralised storage areas	Ability for teachers and students to easily access commonly located resources	Visible or mobile storage drawers or shelves			4		3=		5=				6=	
Spatial openness and vista	Visibility of students and teachers within a space	Larger spaces, higher ceilings, no obstructions, glazed walls/screens			5=				6	1				
Connected spaces	Ability for teachers and students to connect	Open and physically connected spaces								4=			3	
Zones														
Smaller defined areas	Ability for small group, individual and independent work	Alcoves, recesses, nooks, booths, spaces defined by furniture eg. underneath tables									4=		6=	3
Outdoor spaces co-located to internal spaces	Ability to extend learning activities to the outdoors	Outdoor decks, terraces adjacent to indoor learning spaces					4=				4=			
Sink and durable floor covering	Ability for messy activities such as art (exploring, making, doing, experimenting)	Makerspaces, wet areas with sink and durable floor covering, outdoor learning spaces					1=	1=						
More than one vertical writing/projecting surface	Ability to teach to different groups in same space, or change point of focus	Multiple whiteboards and/or projection/digital screens							5=					
Only one vertical writing/projecting surface	A single point of focus for large groups of students	Only one whiteboard and/or projection/digital screen											6=	4
Space for teachers to work together	Ability for teachers to collaborate and plan programs	Shared teacher workspace							3	4=				
Finishes														
Open floor space	Ability to gather large groups, or space for smaller groups to work	Open space on floor for students to gather and/or work			2								6=	
Display space	Ability to display learning protocols and/or student work	Hanging display or vertical surface for pinboard, magnetic panels, or to tape up work	3=											
Furniture														
Seating and horizontal work surfaces	Ability to work sitting down or standing up	Desks, tables, benches, seats, stools	2=	2=		1=						2=	6=	5=
Horizontal, round, flat surface for seated users to work facing each other	Ability to collaborate	Circular tables and seats/stools	3=		5=						3=			
Moveable seating and work surfaces	Ability to change furniture settings	Mobile furniture: tables, chairs, ottomans, cushions, etc			1=		4=							
Technology														
Digital resources	Ability to collaborate virtually, and/or to access information online	Projector, LCD screen, laptops, iPads, BYOD, digital touch tables, green screen, VR, Cloud, WIFI	2=	1=	3	2	3=	2=			2=		5	
People														
Other students	Discussing ideas and working together	Other students	1=				3=							
Environmental														
Natural light, ventilation, air temperature	Environmental comfort	Appropriate building siting, suitable floorplate depths, glazed facades, openable windows									4=	1=		
Acoustic absorption and other devices to support sound quality of space	Ability to hear especially with multiple sound sources within a space	Absorbent ceiling, wall, floor and furniture surfaces, spatial form to minimise reverberation										1=	2	2

Study 2: Participatory action research: Actualising the affordances of ILEs

Methodology

The intent of this study was to seek insights into how teachers can be supported to perceive, utilise and shape affordances within ILE spaces. This study explored the development of 'strategies' and potential 'tools' that may be employed to support teachers to actualise the affordances of ILEs for deep learning. 'Strategies' were defined as an explicit concept, theory or a practice determined from case studies which enhances teachers use of ILEs, and 'tools' as identifiable activities or protocols that implements the strategies (Mahat, Bradbeer, Cattlin, et al., 2018).

Successfully actualising affordances for teaching and learning may involve dealing with an array of factors beyond direct human-environment relations. Teachers may have little experience in recognising the value of space to support better learning outcomes (Leighton & Byers, 2020). In addition, the complexities of school contexts including organisational structures influence teachers' abilities to actualise affordances. Ultimately, optimising the opportunities offered by more open and connected spaces requires a shift in focus from what action possibilities should be afforded by new learning spaces, to how teachers' can best take advantage of ILEs in support of deep learning (Fullan & Langworthy, 2013; Mahat, Bradbeer, Byers, et al., 2018).

A study on how teachers' transition to new learning environments requires an exploration of the interrelated nature of teacher practice amidst shifting systems and structures of complex practice ecologies. Identifying potential strategies and tools to support teachers in shaping their understanding of affordances requires an understanding of teachers' perspectives on their experiences in the process of change to new learning environments. This includes how they are positioned as participants in this change to inform strategies that best suit effective transitions into new learning environments. With a lack of available research on teacher practice change, new ways are required to encourage teachers to think more critically and creatively about the relationships between pedagogy and space.

As a result, this study was designed as a mixed methods analysis with an interdisciplinary research approach. Interdisciplinary research aims to integrate information, data, methods, tools, concepts and theories from distinct bodies of specialised knowledge (Klein, 2015). The interdisciplinary methods employed by the researchers became fundamental to the creation of an innovative research paradigm that structured the production

of knowledge at the site of this research. In this case, methods were characterised by the interaction across and between the methodological approaches of participatory action research (PAR) (Kemmis et al., 2014) and Co-design (Melo, 2018). This approach formed a valuable dimension of this research, seeking to realise new knowledge from participants through the integration of their lived experience within the research framework.

This phase of the study was designed as a collaboration between me and a research partner, Dion Tuckwell, a Monash University PhD candidate also positioned within the ILETC project. My focus was on the PAR methodology whilst Dion's focus was on co-design. Our PAR/Co-design research methodology was an explicit strategy developed to explore teachers' current and future practices in relation to new infrastructure and organisational structures.

PAR and Co-design employ distinct research methods, both of which rethink the relationship between, and foreground, the participant as researcher. These methods align to the more mutually interactive relationships between researcher and participants (Hudson & Ozanne, 1988) commonly associated with interpretivism. Similarly, both research modes explore sites of social practices through activity and collective conversations. These more collaborative research processes derive from constructivism, recognising each person's unique experience and by doing so, enabling greater equity (Crotty, 1998).

Recognising the interpretivist view that humans have the ability to adapt, PAR is a methodology which derives from critical theory seeking to not just understand, but also to improve quality of life. It is known as a 'practice-changing practice' which aims to "change practices, people's understandings of their practices, and the conditions under which they practice" (Kemmis et al., 2014, p. 59). Drawing upon participants' multiple and relative realities (Hudson & Ozanne, 1988), PAR also stems from critical social theory which aims to transform rather than merely explain moments in a transformative process (Carr & Kemmis, 1986).

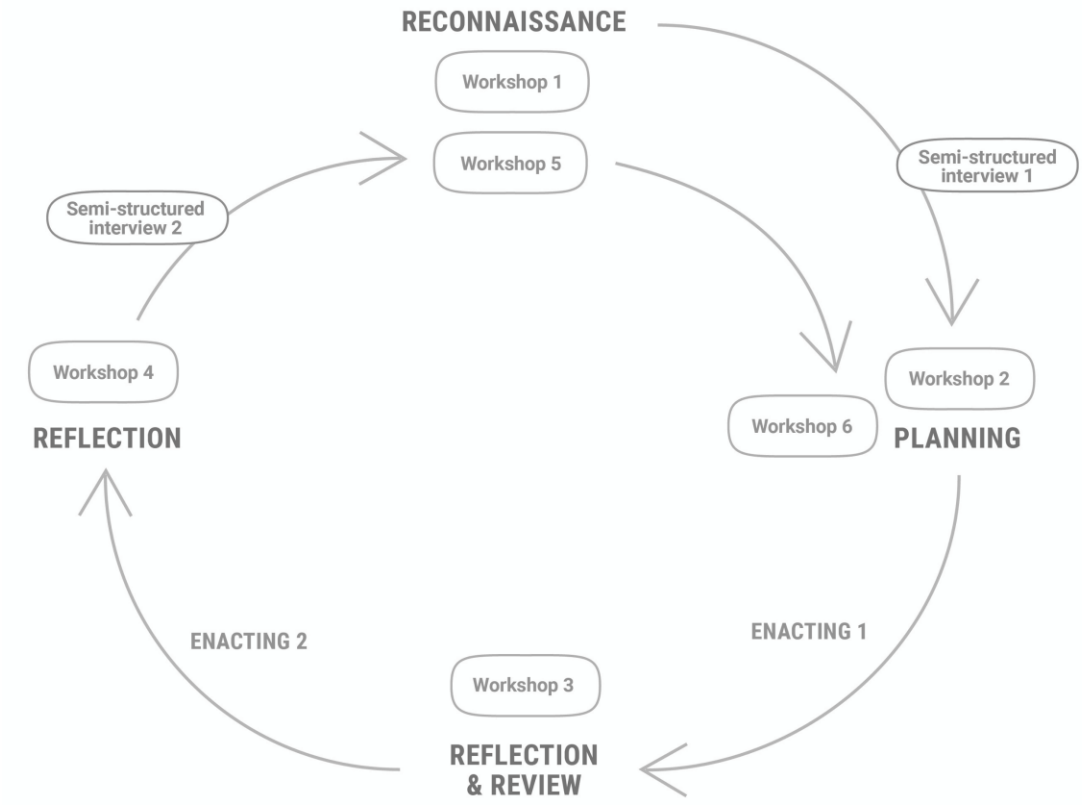
Co-design employs the 'designerly' modes of inquiry as participants make and 'show' their voice through a material heuristic (Sanders et al., 2012). As PAR workshops were co-designed, researchers actively involved all stakeholders in the design process to ensure the designed outcome met their particular needs. The use of co-design strategies provided a pathway for participants to reflect on their own practices and gain deeper insights into the sites of their practice.

The interdisciplinary research process followed a typical action research spiral of planning, acting, observing, reflecting, re-planning, new action and observing, and further

reflection (see Figure 34). Each workshop was initially designed through a discussion between the two researchers, in which I was essentially the 'client', and Dion was the 'designer'. The PAR cycle gave the broad framework for the intent of each workshop, with the first session designed around some of the key learning environment affordances which emerged from the first study. Subsequent workshops drew upon the outcomes from each previous session. Once a concept for a workshop design was developed, this was collectively discussed and adjusted as required to align with the PAR process and my focus on the phenomenon of learning environment affordances. Workshops were largely facilitated by Dion, with me as co-facilitator. For further detail on the authorship of workshops refer to Appendix E).

Figure 34

Participatory Action Research Spiral



Note: Adapted from Kemmis, McTaggart & Nixon (2016).

Research took place in two key stages (see Table 8). The first stage took place between August to December 2018. Stage 1 comprised four workshops focussing on the exploration of strategies to support teachers to actualise the affordances of ILEs as part of their practice. Stage 2 focussed on the testing of tools to support teachers to actualise the affordances of ILEs.

Table 8

Study 2 phases

	Stage 1	**Stage 2**
Date	August - December 2018	August – September 2019
Focus	Exploration of strategies to support teachers to actualise affordances of ILEs	Testing of tools to support teachers to actualise affordances of ILEs
Number of workshops	4	2

Each workshop took a different focus from reconnaissance of current context, to planning interventions, reviewing and reflecting on outcomes (refer Figure 34). Following second and third sessions participants 'enacted' or trialled a range of initiatives discussed in workshops back in the classroom (refer Table 10). These activities drew out deep understandings of current practices at each school. Through this process, participants determined strategies which they iteratively planned, acted upon, observed and reflected upon, empowering them in the process of change. Following the first and fourth sessions participants were asked to participate in a semi-structured interview with one of the researchers.

Data emerging from the first phase of study informed the development of a set of tools that were subsequently designed to support teachers in the development of their pedagogy within ILEs to support collaborative teaching and learning and deep learning. Tools were tested in the second stage, which took place across a two-week period in August and September 2019.

Descriptions of the sites

As an experienced practitioner in school design, I've observed many schools that have encountered difficulties in transitioning from traditional spaces to ILEs. Through my

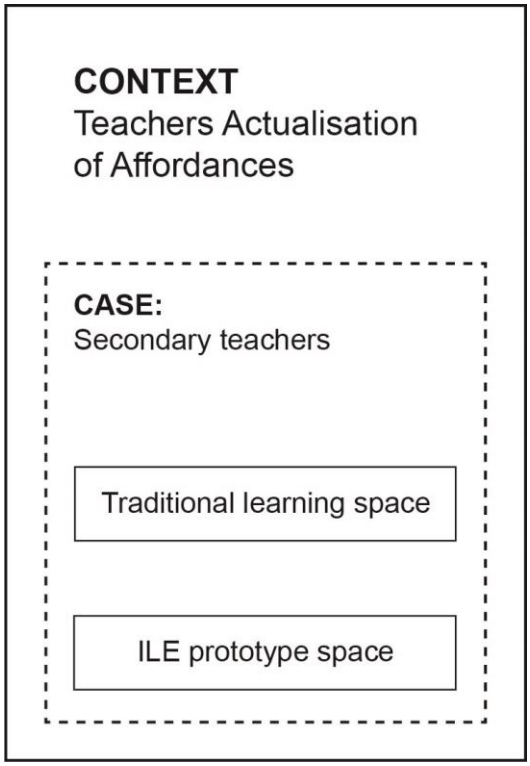
professional network, I have also been made aware of other schools that struggled with the transition to new learning spaces. Although the transition can be an issue across any type of school, it appears to be much more difficult to navigate within the structures of a secondary context. As a result, it was decided to situate this study at secondary level to investigate this issue.

The framing of the second study was based on Yin's (2014) embedded single case study (p.50). The context (or analytical frame or object (Thomas, 2011)) is teacher's actualisation of affordances. The case, or subject of the study is secondary teachers and units of analysis being the teachers from the different secondary contexts (traditional and ILE). Each of the case study components is as follows (see Figure 35):

- Context/object/analytical frame: Teachers actualisation of affordances.
- Case/subject: Secondary teachers.
- Units of analysis: Teachers (from traditional and ILE contexts).

Figure 35

Embedded single case study



Note: Adapted from Yin (2014).

Two school sites were selected for this study: both were in the process of transitioning into new ILEs. Both schools were Year 7-12 Catholic girls' secondary schools in Sydney, New South Wales, at different stages in the development of new ILE spaces. The first school (School A) was referred to the study through one of the educational partners of the ILETC project. The second school site (School B) was a project designed by an architectural practice which was an industry partner of the ILETC project. I am employed with this architectural practice, however I did not work on the design of this project.

School A. School A is located in Western Sydney, with a population of nearly 1000 students. The school has an agenda to transform learning in order to build students' capacity to learn, create and adapt to a fast-changing world. This transformation agenda relates to five key components including pedagogy, professional learning, pathways, partnerships and learning spaces. Major improvement of buildings and therefore learning spaces is seen to be one of the components required to support the schools' agenda. Whilst learning spaces at the school have predominantly comprised single-celled traditional classrooms, plans for new buildings included ILEs.

At the time of the study, learning spaces at School A comprised predominantly traditional single-cell classrooms. This school had participated in the initial ILETC survey (Imms et al., 2017) and data indicated that 80% of spaces were type A and 20% of spaces type B (Dovey & Fisher, 2014). Plans were underway for several new building projects with a new two-storey performing arts building expected to be completed by term one 2020. Another building project comprising refurbishment of traditional spaces to ILEs was due for completion in mid 2020. Refer Appendix I for site drawings and building floor plans.

School B. School B is located in metropolitan Sydney with an enrolment of 675 students. The school's learning philosophy is based on the concept of growth mindset (Dweck, 2012), supporting a view that students talents and abilities can be developed through effort, good teaching and persistence.

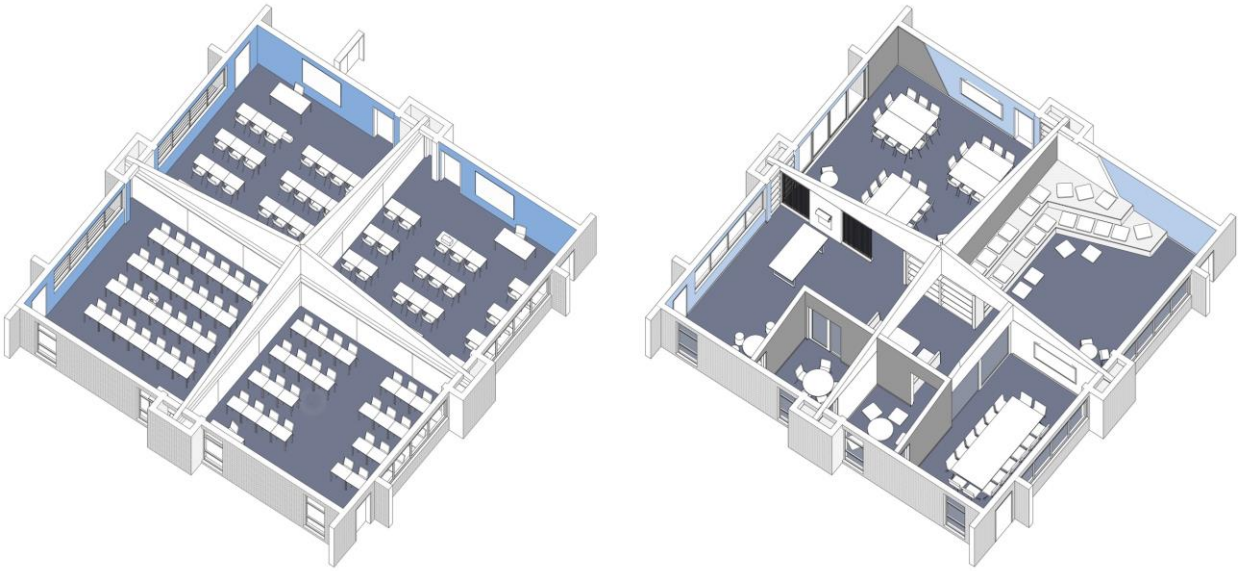
Facilities at this school are a mix of heritage and newer buildings built up until the late 1980's with the majority of learning spaces comprising traditional classrooms. In 2016, a masterplan was developed for the school with the vision to upgrade the campus to deliver modern, new and dynamic facilities and resources for its students and teaching staff. The aspiration for the masterplan was for school infrastructure to enhance the student learning

experience in supporting students to enter their next 21st century tertiary education and working phase.

The first building to be constructed as part of the masterplan, a new library and Year 7 and 8 centre, is due (at the time of writing) for completion in 2021. Refer Appendix J for site drawings and building floor plans. In recognising the need to support teachers and students to transition from traditional classrooms to this new ILE building, the Principal commissioned a small prototype learning space. This space is a refurbished 200 square metre traditional classroom block which originally contained four separate classrooms. It is designed to accommodate two to three class groups and incorporates many affordances which would be incorporated into the future new building. This includes a range of interconnected and purposeful spaces for different sized groups, including a large tiered space for performance and presentation, a more traditional tutorial space for whole class groupings, an enclosable 'Boardroom' for small group meetings, two small 'Incubator' spaces for withdrawal and retreat, booth seating and a range of different types of furniture (refer Figure 36). This prototype space became the focus of the first stage of the action research project for this school.

Figure 36

School B prototype learning space



Note: Image courtesy of Hayball.

Participant selection

Stage 1. Participants from both schools were invited by school principals to be part of the study. At School A seven teachers across key learning areas (KLAs) participated in the first stage of research. At School B, there were eight participants which included seven teachers plus the Principal. Only four School B teachers were able to participate in the first workshop, however, an additional four participants joined for the remaining workshops and interviews. Over the course of the four months some teachers were absent for workshop sessions with the total number of attendees involved at each phase of the research process shown in Table 9.

Table 9

Number of attendees at stage 1 workshops and interviews

	Number of workshop and interview participants	
	School A 7 participants total	**School B** 8 participants total
Workshop 1	7	4
Workshop 2	6	8
Workshop 3	6	7
Workshop 4	6	8
Semi-structured interview 1	7	8
Semi-structured interview 2	6	7

Stage 2. In the second stage of research, there was a total of nine participants from School A and 10 participants from School B. Some participants (from both schools) had been involved in the earlier stage of research, however a few newcomers to the research process were also nominated by school principals to participate. In school A, three new participants were selected as they were likely to be working in the new ILE. In school B, all participants were part of the team who would be working together in the new Year 7 and 8 building.

Methods

Data collection

Across both stages of Study 2, a range of techniques were employed in the various workshop sessions to support participants to engage in discussions about the process of change. Each of these workshops are discussed in detail in this section. All workshops and semi-structured interviews were audio recorded and transcribed. Participants at each school planned the initiatives they would trial during the course of the research period using a shared Google document and these were made available to the researchers (see Figure 40).

Stage 1. A local-context research question positioned the focus of the study within each school. As the context for each school was slightly different, with one school having only traditional learning spaces whilst the other had a recently built prototype ILE space, the research question for each of the studies differed.

The local-context research question for School A was "How can we prepare ourselves to effectively use our proposed new learning spaces?" While the local-context research question at School B's question was "How can we enhance our use of our new prototype learning space for student deep learning"?

This study comprised of four facilitated workshops, with a different focus in each session: reconnaissance, planning, review and reflection (refer Figure 34). A description of each of the workshops follows.

Workshop 1: Reconnaissance. Participants were provided with a series of fifteen learning principles printed onto yellow cards. Each participant selected three cards which most resonated with their beliefs to discuss with the group. These principles had been adapted from the work of Mattingly (2016), who had distilled twelve principles from recent research literature. A list of the principles used is as follows:

1) Getting frequent feedback and ways to use it are important for student learning.
2) Deep learning often happens when students are confused, struggle, and even fail.
3) Extensive discipline knowledge is important to be an effective teacher.
4) Lessons should be designed to accommodate a range of learners.
5) Good instruction makes concepts and learning easy to grasp.
6) Students should be consistently challenged and held to rigorous standards.
7) Enduring learning requires multiple opportunities to learn something over time.

8) Students need to be taught how to learn effectively.
9) Effective effort mostly determines the highest performers in schools.
10) Ascertaining prior student knowledge and skills is a key to teaching success.
11) Deep, durable, and transferable learning is highly effortful.
12) Collaborative learning with lots of student talk is an effective way to learn.
13) Metacognition (thinking about how one thinks) is a key learning skill and mindset.
14) A student's sense of self-efficacy is crucial to their academic success.
15) Direct instruction is a useful way to convey large amounts of important information.

Participants then paired up with another participant who had the most similar selection. The pairs distilled their selected principles to a total of three, which they then reviewed in relation to a series of spatial qualities (emergent from Study 1). Spatial qualities were printed to A4 transparencies and each group indicated whether the qualities 'enabled' or 'constrained' each selected learning principle (refer Figure 37).

Participants wrote notes on the transparency to explain the decisions they were making. Following this exercise each group shared their learning principles and decisions made around the relationship to various spatial qualities. The decision to use transparencies for this exercise allowed each transparency to be juxtaposed, revealing patterns between the responses of the different pairs.

Workshop 2: Felt concerns. After Workshop 1, semi-structured interviews took place with all participants. Interview transcripts were coded, and initial themes, or felt concerns, reflected back to participants. Participants had the opportunity to provide feedback on whether these felt concerns accurately represented their views (or not), and whether they needed to be supplemented. They were then invited to vote on the felt concerns they felt were of most importance to explore (refer Figure 38).

Potential strategies that could be tested to explore these concerns were discussed amongst the group. Each participant wrote multiple strategies on a series of Post-it notes which were then collated and themed into common clusters which the group discussed (refer Figure 39). It was decided that participants would all determine an initiative to trial prior to the next workshop. A Google document was used to capture the range of initiatives each participant would explore, and how they would measure the outcome of this initiative (refer Figure 40).

Figure 37

Workshop 1: Affordance enablers and constraints

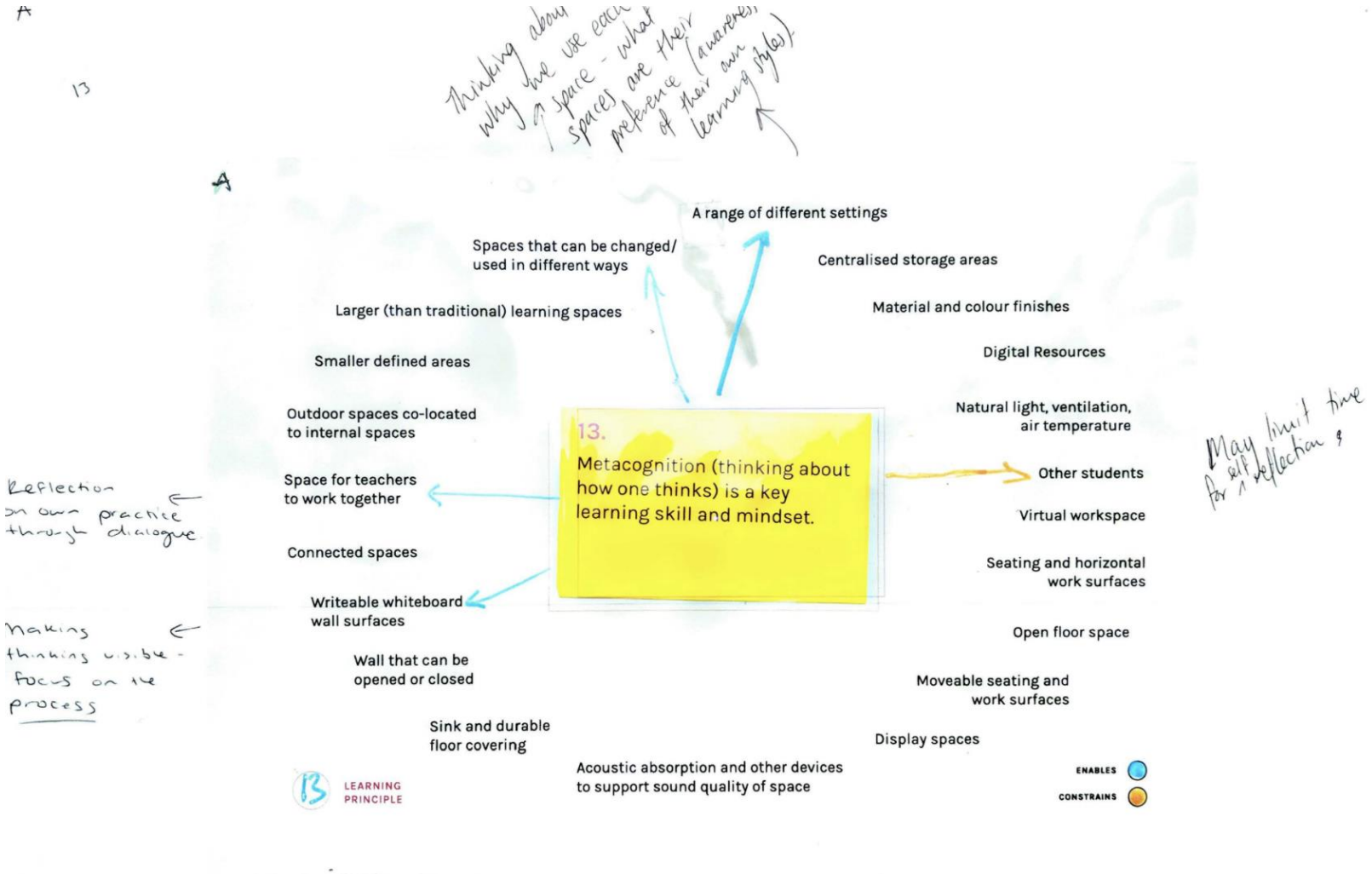


Figure 38

School B tally of most important felt concerns

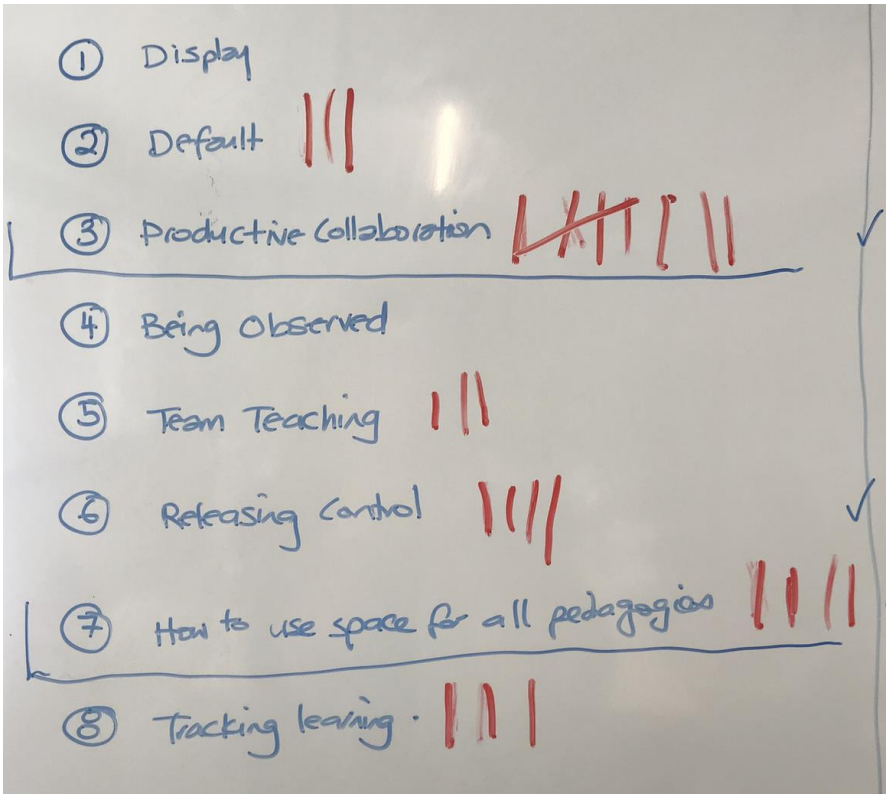


Figure 39

Strategies to trial clustered into themes

Figure 40

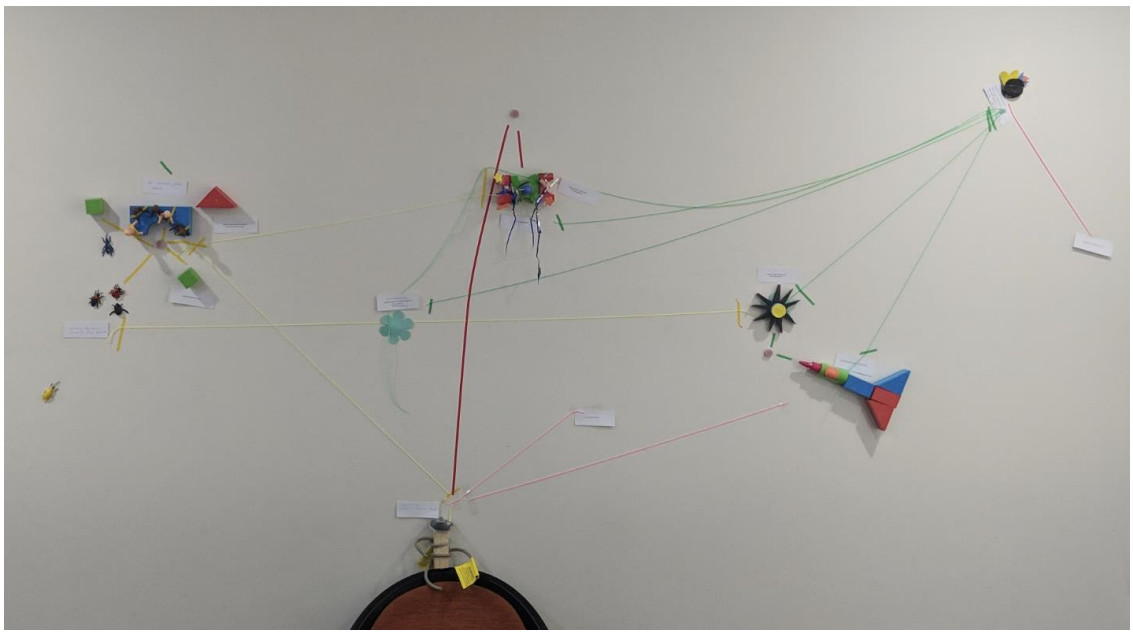
Google document of strategies to trial (School B)

Name	Faculty	What strategy I would like to test?	What will I do?	How will I measure the effectiveness of this strategy?
[redacted]	Visual Arts	• Observation • Productive Collaboration	Year 10 Visual Arts: Renaissance Group Task Students further explore the Renaissance and Modernism by investigating a chosen Renaissance artist. Students are grouped with other students of similar ability and the task is differentiated. Students have been grouped with other students of similar ability and are given roles within their group. Students complete an evaluation of the space, group work and their peers.	• Student Feedback • Teacher Observation1 (Eugene Au-Yeung) • Teacher Observation2 (Anita Rombola)
[redacted]	Geography	• Productive Collaboration (student perceptions of effective learning - Do they recognise how grouping can affect productivity?)	**Year 10 Geography:** Students are working towards a formal assessment on Environmental Change and Management and I will allocate groups for students to research and plan their task. They are being given class time (assessment AS learning) • Lesson 1 (Wed) - Students will be grouped according to the Environment they have chosen to research • Lesson 2 (Fri) - Students will be based	• Student Feedback - through Google Form • Teacher reflection/observations of student

Workshop 3: Reflection and review. As a warm-up exercise, participants in this session were first asked to select from a series of images - one of which captured their experience of change - and to describe this to the group. Participants were then asked to engage in an exercise centred around a metaphor of a solar system to reflect on what they had trialled. They worked in small groups to create objects from a range of materials that represented 'outer space'. Drawing from the experience of their recent trials, objects were to reflect things that enabled (e.g. space station) or constrained (e.g. black hole) the use of new learning spaces. These were positioned on the wall relative to a symbol denoting each groups' 'planet' (Figure 41). Each group described the objects which they made and attached coloured tape between objects which enabled or constrained their practice. After hearing what each group had created, participants were then invited to re-adjust what they had positioned in relation to not just their planet, but to connect into other's useful interventions as well. In this way, participants were drawing upon the initiatives and support of the community of practice as a whole.

Figure 41

Solar system as a metaphor for a community of practice transitioning to an ILE (school A)



This workshop concluded with a polaroid image taken of each participant in front of their 'planet' which was then made into a postcard 'commitment device' which described a metaphorical experience of the transition to an ILE. Participants once again determined how they would trial practice prior to the next session in relation to the use of ILEs. Once again,

decisions were documented via Google documents. The range of initiatives trialled by participants across Stage 1 are shown in Table 10.

Table 10

Initiatives trialled by teachers

School A	School B
• Rearranging furniture in existing classrooms to create more diverse learning settings • Initiatives to support students to understand the intent of new furniture arrangements • Stepping back to encourage students to use the whiteboard • Using Google documents with students to track their learning • Trialling team teaching with other participants	• Team teaching • Observing each other's practice • Using the prototype space more intentionally for collaborative learning

Workshop 4: Reflection. Workshop 4 focussed on exploring whether there were changes to participants practice across the duration of Study 1. Participants were first asked to draw on an A3 sheet of paper an image of how their practice looked at the start of the research process. They were then asked to superimpose this image with a clear sheet of transparency and to draw onto this sheet 'what their practice was becoming'. Participants were provided stickers to use as symbols (denoting various aspects such as objects or people) within their drawings (refer Figure 42). They then discussed their experiences with the whole group.

Figure 42

School A participant drawings showing what their practice 'was', and what it 'was becoming'

Following the first and fourth sessions participants were asked to participate in semi-structured interviews. The first round of interviews focussed on participants' current contexts. Questions related to interviewees' perceptions and experiences of the learning spaces they were currently using and also addressed aspirations, fears and expectations around use of the new learning spaces proposed for their school. The second round of interviews was centred around participants' experience of the PAR/Co-design process and whether their awareness or use of space had changed over the research period. The questions asked in the semi-structured interviews are outlined in Table 11.

Table 11

Study 2 semi-structured interview questions

<table>
<tr><th></th><th>School A</th><th>School B</th></tr>
<tr><td>Research question</td><td>How can we prepare ourselves to effectively use our proposed new learning spaces?</td><td>How can we enhance our use of our new prototype learning space for student deep learning?</td></tr>
<tr><td rowspan="4">Semi-structured interview 1 questions</td><td>What do you find exciting or daunting about the proposed refurbishments to your school?</td><td>What do you find exciting or daunting about the proposed new Year 7/8 & library building?</td></tr>
<tr><td>What do you hope to be able to do in these spaces that you can't do now?

Do you expect to teach differently in the new learning spaces?</td><td>Do you expect to teach any differently in the proposed new Year 7/8 & library building?</td></tr>
<tr><td>What types of spaces do you teach in now?

How do you think these spaces enable or constrain your teaching?</td><td>What are your experiences of teaching in the prototype learning space?

Have you taught differently than you would in other parts of the school?

Do you find the space constraining in any way?</td></tr>
<tr><td colspan="2">How do you think your past experience will inform your future teaching practice?</td></tr>
<tr><td>Semi-structured interview 2 questions</td><td colspan="2">Were there any particular moments during the research process that raised your awareness around space as a teaching resource to enable learning activities and support you in your practice?</td></tr>
</table>

	What did you find difficult in the process? What did you find most effective in the process? Are there any insights, techniques, discussions from the PAR/Co-design process which you think has or will help you in transitioning to the new building/using the prototype learning space? What support structures were/are required to enable this transition?	
	Have you (or will you) continue to trial and test practice beyond the PAR process?	
	Did you consider trialling something related to planning lessons together or Team Teaching?	Are you using the prototype learning space differently than prior to the first workshop in August?

Stage 2. A synthesis of outcomes from Stage 1 directed the design of the Stage 2 process and workshop activities. These activities were envisioned as part of developing a 'tool' that could be used by any teachers (or schools) into the future regardless of whether they had participated in Stage 1 or not. Therefore, it was beneficial to trial this both with teachers who had been part of the earlier discussions (in Stage 1) as well as those who had not.

Workshop 5. The first workshop focussed on priming participants around 'perceiving' potential affordances of their existing learning spaces as well as the new learning spaces in development. It also explored their perceptions around changes that would take place as a result of teaching in the new learning spaces. The workshop comprised three parts (refer Figure 43):

1) From a range of characters participants selected avatars that reflected their current experience and described their selection to the group.

2) On a topographical map, participants constructed interventions using random materials which described their sense of the current learning environment context around them and placed their avatars into this scene. The lines on the topographic map were symbolic of landscape elements such as mountaintops, steep (or gentle) slopes, valleys and plateaus.

3) Participants created field guides which they would use to observe issues they identified as important or of interest to them. On the rear of the field guide,

participants suggested items of interest or concern that had been part of the workshop discussion. Two blank pages inside the field guide allowed space for participants to note their observations prior to the next workshop.

Figure 43

Study 2 Workshop 2: Avatar, Topography and Field Guide

Workshop 6. The second workshop focussed on supporting teachers to have conversations about affordances and develop protocols to help them 'utilise' the affordances of their new ILE spaces. Tools trialled in this session were intended to help teachers evolve their own understandings of learning environment affordances and to begin to 'shape' these towards new individual and collective abilities to perceive and utilise affordances (Heft, 1988, 1989; Kyttä, 2002, 2004; Young et al., 2019). This workshop comprised three activities (refer Figure 44):

1) Reflecting on field guide observations made between workshops one and two.

2) *Ecology*, creating a model polyhedron in which each side was used to synthesise an observation through the lens of infrastructure, practice and organisation.

3) MakingSPACE: Strategies and protocols to activate collaborative environments.

This was a tool which enabled participants to explore floorplans of their future new ILE spaces using to-scale avatars of furniture and people (teachers and students) to determine what protocols might be needed in order to be able to collectively work together effectively in these spaces.

Figure 44

Study 2 Workshop 2: Ecology and MakingSPACE: Strategies and protocols to activate collaborative environments

Teachers were asked for their initial reflections of the process following each workshop. An online survey was also issued to participants from both schools at the end of both workshops. The survey questions were based on a four-point Likert scale to gauge whether the activities were useful to them or not. A selection of questions from the survey are shown in Table 12.

Table 12

Example of Study 2 online survey questions

Workshop 5: Perceiving Workshop 5 was intended to support teachers to reflect on their current context in order to begin to explore their perceptions around their use of learning spaces. On a scale of 1 (not well at all) to 4 (extremely well) how well do you think this session supported you in doing this?
In *The Avatar* you selected a character which represented you as a teacher now in relation to the use of new learning spaces. On a scale of 1 (poor) to 4 (very well) did you find this process a useful way to articulate your thoughts around this question?
What was helpful or unhelpful about *The Avatar* exercise?
In *The Map* you were asked to use materials to create a 'landscape' of the current teaching environment in order to explain how you felt about the journey from your current spaces to the new building.

On a scale of 1 (poor) to 4 (very well) did you find this process a useful way to articulate your thoughts around this question?
What was helpful or unhelpful about *The Map* exercise?
In *The Field Guide* you were asked to identify elements which you were interested in observing in your current practice. On a scale of 1 (poor) to 4 (very well) did the *Field Guide* help you become more aware of the influence of space on teaching and learning activities and behaviours?
What was helpful or unhelpful about *The Field Guide* exercise?
Workshop 6: Utilising and Shaping This workshop was intended to support teachers to translate observations from and understandings of their current practices aligning pedagogy and space to their proposed new learning spaces. On a scale of 1 (poor) to 5 (very well) how do you think this session supported you in doing this?
In *The Ecology* you were asked to write one of your observations from the Field Guide into a triangle and then reflect on how this related to either organisation, practice or infrastructure. On a scale of 1 (poor) to 4 (very well) did you find this process a useful way to think about the interrelated aspects of pedagogy, space and school organisation?
What was helpful or unhelpful about *The Ecology* exercise?
In *Making SPACE* you were asked to use the floor plan of your proposed new learning spaces to consider how students (beads), teachers (eyes) and furniture might inhabit the spaces. You were then asked to annotate on the page your thoughts around this process and protocols that would be required in order to successfully co-inhabit the future building. Finally you were asked to translate these protocols to the yellow 'protocol' cards. On a scale of 1 (poor) to 4 (very well) did you find this process a useful way to better understand the opportunities and constraints of the proposed new building/learning spaces?
On a scale of 1 (poor) to 4 (very well) did you find this process a useful way to begin to articulate protocols for shared use of these spaces?
What was helpful or unhelpful about the *Making SPACE* exercise?
Overall reflections What do you think could have been improved by this process?
Do you think this process could have been fast-tracked? If Yes, which elements of the process could have been adapted or removed?

Analysis of data

All workshops and semi-structured interviews were audio recorded. Recordings from workshops and interviews were transcribed, and using NVivo software, interviews coded based on a thematic analysis approach (Braun & Clarke, 2006). This was similar to Study 1 discussed above. Field notes and workshop transcripts were read to draw out key comments from participants relating to themes from semi-structured interviews revealing further insights into the study.

Participants from both schools used Google documents (refer Figure 40) to collate information on the initiatives they planned to trial and how they intended to measure these. Google documents were also used by some participants to capture student feedback from discussions, emails, or surveys. Researchers were provided access to the Google documents created by representatives from each school and this data was read to gain further insights into the study. Whilst video recordings were used as the primary source of analysis by my research partner as part of his study into Co-design, I did not analyse these as part of my study.

Coding and analysis processes of participant semi-structured interviews in Study 2 are similar to the examples shown in the Data Analysis section earlier in this chapter. Refer Figures 31 and 32 for examples.

Citations to participant quotations throughout this dissertation vary, depending on the source. Participants in semi-structured interviews were easily identifiable and are cited as follows:

- Study 1: (Teacher (number), Site (1 to 5)).
- Study 2: (Teacher (number), School (A or B)).

However, in Study 2 workshops, there were multiple voices engaging in discussion, which often made it difficult to recognise participants in the audio recordings. Therefore, quotations from workshop discussion are cited as (Workshop participant, School (A or B)). For a list of participants, showing teacher numbers relative to study, site and school, refer Appendix C.

The influence of the researcher on the social settings

The intent of the Participatory Action Research/Co-design study (Study 2) was to work together with participants in order to collectively explore ways in which educators can change practices to transition from traditional learning spaces to ILEs. In this type of study,

the researcher empowers research participants by helping them understand their context in order to make changes. In critical participatory action research, responsibility for the research is taken collectively, as are decisions about what to explore and what to change (Carr & Kemmis, 1986).

I (and my research partner) frequented both school sites numerous times (six) over a 13-month period, developing rapport with, and becoming familiar to participants. The techniques used in workshops were designed to encourage opening communicative space (Kemmis & McTaggart, 2005) and draw out latent thoughts and ideas from each and every participant. They were also intended to encourage individual reflection and collective dialogue in order to determine actions. Data emerging from workshop dialogue and semi-structured interviews during the course of the research period was presented back to participants in order to clarify whether these accurately reflected their views or needed adjustment. The processes described above, and the active engagement of participants through trialling and testing initiatives, reduced the sense that research was being done to participants and that they themselves were active researchers as part of the process.

Ethical considerations

As this research included interviews, surveys and focus groups with human participants, ethics clearance was required. Risks and benefits were assessed for this project, and no perceived risks were identified for either participants or researchers conducting this work.

Ethics clearance was granted for the study by:

- The University of Melbourne Human Ethics Advisory Group (Ethics ID: 1749828).
- School Policy and Information Management, NSW Department of Education (SERAP 2017555).
- The Government of South Australia Department for Education and Child Development (DECD) (DECD CS/17/000750-1.12).

The case study school principals were required to provide specific consent for the research to be conducted in their schools. The following measures were taken to minimise potential risks to participants in the project:

- Plain language statements and consent forms which outlined the purpose and particulars of the project were provided to participants. Separate documents were

created for school principals, teachers and designers. (see Appendices A & B for copies of the plain language statements and consent forms).

- It was made clear that participation in this study was voluntary. Participants were given the opportunity to withdraw from the research at any time and/or ask that unprocessed data that was previously supplied be withdrawn.
- The names of the case study sites and the names of participants were not used in the research findings. Schools and participants are referred to by pseudonyms in publications arising from the research.
- Data will be stored for a minimum of five years after the date of any publication or public release of the work of the research. Data in the form of audio recordings and (coded and uncoded) transcripts will be disposed of in accordance with The University of Melbourne code of conduct for research.

Supplementary research experiences

In addition to the theorising and field-based research phases of the study, a number of other activities supported the development of my overall understandings of the field of inquiry. These activities included participating in ILETC project meetings, attending conferences and seminars, as well as engaging with a range of schools and design teams as part of my role at Hayball.

I participated in numerous ILETC project workshops and partner meetings with project academics, other ILETC PhD candidates and industry partners, which gave opportunities to hear how other researchers were approaching related issues around ILEs and transitioning teacher practice, and to understand the project more holistically. As a multidisciplinary project, with academics, researchers and partners representing fields of architecture and design, as well as education, the cross-disciplinary conversations have been extremely valuable in processing my understanding of the topic. Since the project started in June 2016, there have been 14 PhD workshops (approximately three per year), and four Partners meetings.

The Learning Environments Applied Research Network (LEaRN) and the ILETC project have run a number of symposiums each year which I have attended. This has given further exposure to the research and thinking taking place in relation to learning spaces, from a wide range of researchers from Australia, New Zealand and more globally. During my

candidacy I attended and presented in conferences and seminars in Melbourne, Sydney, Chicago and New Zealand (these are listed in the Preface).

Through conferences and as part of my work at Hayball, I have visited many schools that have new learning spaces or are renowned for progressive pedagogical practices. At these site visits, informal conversations with school leaders, teachers, students, architects and designers have helped contextualise my research.

Reflections on rigour of the research design

The nature of the research questions and design of the research has resulted in a two-stage qualitative study – the first stage based on a case study methodology and the second informed by critical social theory as a PAR study. I will now discuss the suitability of these methodologies and methods through criteria associated with *trustworthiness* (Lincoln & Guba, 1985), a concept used to assess the quality of qualitative research. These criteria are credibility, transferability, dependability and confirmability (Baxter & Jack, 2008; Bryman, 2012; Lincoln & Guba, 1985; Nowell et al., 2017).

Credibility

Sufficient detail is required to assess credibility and the validity of research. In relation to case studies, Baxter and Jack (2008) suggest five criteria as a basic foundation to achieve this: a) the research question is clearly written, b) the design is appropriate to the research questions, c) purposeful sampling strategies have been applied, d) data are collected and managed systematically, and e) data are analysed correctly. This chapter has set how out each of these criteria have been applied to the case studies in Study 1.

Triangulation of data sources, types and methodologies promotes credibility by ensuring that phenomenon are explored through multiple perspectives (Baxter & Jack, 2008). As an embedded multiple case study (Yin, 2014) with five different sites, Study 1 utilises *space triangulation* overcoming the parochialism of studies conducted within the same subculture (Cohen et al., 2018). Each case is investigated through a range of methods, including on-site interviews, auto-photography and semi-structured interviews, which Denzin and Lincoln (2011) refers to as *methodological triangulation*. *Member checking* (Lincoln & Guba, 1985) also took place in both studies, in which initial synthesis of the on-site interviews in Study 1 were shared with participants during semi-structured interviews. This provided the opportunity for participants to discuss and clarify my interpretations, and

contribute new or additional views (Baxter & Jack, 2008). Similarly, in Study 2, coded interviews were shared with participants in the second workshop in order to gauge validity of the researcher's synthesis of the initial workshop and first round of semi-structured interviews. As a longitudinal study which took place over a year, the second (PAR) study also demonstrated *time triangulation* (Cohen et al., 2018). The prolonged exposure to the phenomenon under study in context enabled a rapport with participants allowing multiple perspectives to be collected and understood (Baxter & Jack, 2008).

I had many opportunities for the study to be externally checked through *peer debriefing* (Lincoln & Guba, 1985; Nowell et al., 2017). This took place through discussions with my supervisors, and fellow ILETC project team members at the numerous PhD and partner workshops that have taken place each year since the beginning of the ILETC project.

Transferability

Thick descriptions (Geertz, 1973) were used to provide rich details of the culture (Bryman, 2012) of the sites in both studies. This allows others who seek to transfer findings to their own sites to determine transferability (Lincoln & Guba, 1985; Nowell et al., 2017) and connection to other situations.

Dependability

Dependability refers to ensuring the research process is logical, traceable and clearly documented (Nowell et al., 2017; Tobin & Begley, 2004). Records have been kept from all phases of the research process including memos, journal notes and field notes. Documentation includes notes and diagrams used to process general theoretical understandings around affordances, decisions made around selection of research participants, interview transcripts, and data analysis decisions. Research processes for each stage of the field work have been clearly documented to ensure consistency of approach at each of the sites. Examples of a process checklist used in Study 1 are shown in Appendix D.

Confirmability

Confirmability relates to establishing that findings are clearly derived from the data (Nowell et al., 2017) and that the researcher has not overtly allowed personal values to sway the conduct of the research. Guba and Lincoln (1989) note that this is achieved when credibility, transferability and dependability (as discussed above) have all been achieved.

Authenticity

Lincoln and Guba (1985) include *authenticity* in addition to the four trustworthiness criteria listed above (Bryman, 2012). The authenticity criteria are particularly pertinent to Study 2, the PAR study. Criteria includes *ontological authenticity* in which participants gained a better understanding of their social context; *educative authenticity* in which participants gained a better appreciation of other perspectives within their social setting; and *catalytic authenticity* in which the research acted as an impetus for participants to engage in action to change their circumstance.

Limitations of the study associated with its design

A few limitations of the study have been identified. Firstly, sampling for the first study was reliant on data from the initial ILETC survey. Whilst having data of this scale (822 responses) to draw upon was invaluable to provide an understanding of the types and contexts of schools across Australia and New Zealand and potential case studies, the researcher was reliant on accuracy of the data provided, based on the perceptions of respondents who filled out the online surveys.

In the second PAR study time available for teaches to participate in workshops was a constraining factor. Workshops were tailored to suit allocated times available at each school, however this meant that school A sessions were typically between 75-90 minutes long, whereas school B sessions were between 105-120 minutes long. The reduction in duration may have influenced the impact of workshop activities on school A participants, however outcomes emerging from these workshops were still of value to the study.

Other limitations include difficulty in replicating the research due to the unique social settings and temporal ‘designerly’ elements of the study. As a result, this may reduce the transferability of findings to other settings or contexts restricting the scope of the findings to the sampled populations. These potential limitations are believed to have been outweighed by the strengths of the research approach and the transferability of the proven methodology.

Conclusion

This chapter sets out the rationale for how the research was carried out as part of my study and on what grounds the research was based. It outlined the theory of knowledge (epistemology) embedded in the theoretical perspective and in the methodology; and the

philosophical stance (theoretical perspective) informing the methodology and thus providing a context for the process and grounding its logic and criteria (Crotty, 1998). The ontology, epistemology and theoretical perspective directed decisions made behind the choice and use of particular methods, linking the choice and use of methods to the desired outcomes (methodology) (Crotty, 1998). Finally, techniques or procedures (methods) used to gather and analyse data relating to research questions and hypothesis (Crotty, 1998) were explained. The material presented in this chapter was intended to provide a framework by which to judge the quality of the research findings.

The following chapters (Chapters 4-6) outline the findings from Study 1 and Study 2. These findings are also discussed in the context of the literature to draw out the insights and meanings that were developed.

Chapter 4. Do You See What I See?

Introduction

This chapter presents and discusses the learning environment affordances identified by educators and architects in Study 1. It addresses the research questions, *What are learning environment affordances?* and *How are they perceived by educators and architects?*

Findings are reported from an embedded multiple case study (Yin, 2014) which involved teachers and architects at five educational sites, four of which were schools (two primary and two secondary) and one a dedicated museum learning space. At each site, two architects and four teachers were interviewed and engaged in an auto-photography (Thomas, 2009) exercise to find out what affordances were recognised. Participants were also asked whether identified affordances had specific alignment to the pedagogical approaches of team teaching, and collaborative, interdisciplinary and deep learning. On-site interviews and subsequent semi-structured interviews were recorded and transcribed. Transcriptions were coded using qualitative content analysis (Cho & Lee, 2014). This enabled emerging themes to be quantified based on how frequently they were identified by different participants.

A series of affordance taxonomies were developed from the findings from this study. Six categories of affordances perceived by architects and educators that supported a range of deep learning pedagogical approaches were identified. Findings also show affordances relating to different spatial typologies (Dovey & Fisher, 2014) and varying perceptions by architects and educators of the benefits of space for learning. These findings will direct the activities of the second study which sought to understand strategies and develop tools which could help educators actualise the affordances of ILEs. These will be discussed in Chapter 6.

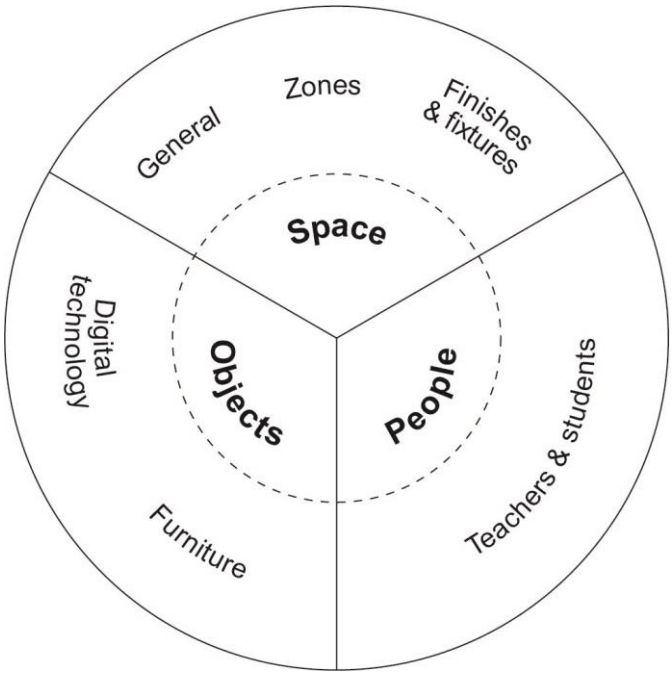
Findings and discussion

Categories of learning environment affordances

Through the coding process, six categories of affordances emerged: general, zones, finishes and fixtures, furniture, digital technology and people (refer Figure 45). These categories fit within the three major themes of space, objects, and people. Within these thematic groups, ‘space’ refers to spatial qualities with distinguishable ‘zones’, such as smaller defined areas, large group areas, teacher work areas, open floor space or outdoor learning spaces. It also includes ‘finishes and fixtures’, such as writeable wall surfaces, retractable walls or curtains, and large-scale environmental graphics.

Figure 45

Categories of learning environment affordances



‘General’ items refer to higher-level ‘parent’ affordances. These typically include clusters of ‘nested’ affordances (Gaver, 1991) that integrating others from across the three thematic groups. For example, the parent affordance ‘having different settings within the same space to enable different ways for students to work’ might include a range of zones and furniture to create these different settings for students to interact.

The thematic grouping of ‘objects’ refers to more discrete elements such as ‘furniture’ for sitting, working or storing things, and ‘digital technologies’, such as computers, tablets and projection screens. The ‘people’ category refers to other teachers and students, identified by educator participants as affording a variety of teaching and learning opportunities.

A taxonomy of affordances identified by architects and teachers is shown in Table 13. This listing comprises 43 different affordances comprised of their spatial qualities and their relative action possibilities or teaching and learning activities and behaviours. It also shows how each affordance could manifest as different features or elements. For example, low soft seating which allowed people to work in comfortable settings could take the form of a couch, a beanbag or a floor cushion.

Table 13

Affordances perceived by educators and architects across case study sites

	Affordance		
	Spatial Qualities	**Action Possibility**	**Feature/Element**
space	**General**		
	A range of different settings	Different ways for students to work	Zones, furniture and surfaces
	Multi-use spaces that can be changed or used in different ways	Ability to adapt spaces to suit learning activities	Flexible spaces defined by moveable walls, mobile or agile furniture
	Spatial openness and vista	Visibility of students and teachers within a space	Higher ceilings, larger spaces, glazed screens
	Uncrowdedness/space to move	Ability for teachers to easily move around to different groups of students	Adequate space between furniture
	Natural light, ventilation, air temperature	Environmental comfort	Suitable floorplate depths, glazed facades, openable windows
	Zones		
	Smaller defined area	Small group, individual and independent work	Alcoves, recesses, nooks, booths
	Separable smaller space	Quiet individual activities, or small group activity	Breakout room with acoustic separation
	Large group area	Gathering large group for explicit teaching	Area to fit large group (either seated or on floor)
	Outdoor learning spaces	Ability to extend learning activities to the outdoors	Outdoor decks or terraces adjacent to indoor spaces
	Spaces with a sink, durable floor covering	Ability for messy activities (making, doing, experimenting) including art and science	Wet area, Maker space, Laboratory
	Open floor space	Gathering large groups, or smaller group work	Area of open floor space for large or small groups
	Space for teachers to work together	Ability for teachers to collaborate and plan lessons	Teacher collaboration workzones
	Finishes/Fixtures		
	Empty wall space (or pin board)	Display of learning protocols and/or student work	Vertical surface for pinboard and/or magnetic panels
	Wall that can be opened or closed	Ability to connect or separate spaces	Sliding, retractable or pivoting wall
	Writeable wall surface	A primary focal point to display information	Whiteboard or whiteboard wall surface
	More than one vertical writing and/ or projecting surface	Ability to change point of focus or for multiple groups to have different points of focus in same space	Multiple whiteboards and/or digital screens located around space
	Writeable glazed surface	A writeable surface, definition between zones whilst maintaining visibility throughout the space.	Glazed screen
	Large circular floor graphic	Demarcating specific activities or gathering groups of students	Floor markings defined by carpet or paint
	Retractable curtain	Making a space darker, and connecting or separating spaces	Curtain or blinds

Note: From Young et al. (2019, p. 717)

Table 1

(continued)

	Affordance		
	Spatial Qualities	**Action Possibility**	**Feature/Element**
object	**Furniture**		
	Horizontal sitting and working surfaces	Working sitting down, on tall stools or standing up	Desks/tables, high tables, benches, seats, bar stools
	Table height horizontal surface for 4-6 users	Ability to collaborate	Group table seating four to six people
	Table height horizontal, round, flat surface	Facing other students for collaborative activities	Circular table
	Table height horizontal writeable surface	Freedom for students to test ideas	Whiteboard table
	Table height individual work surface	Independent work	Single desks or bench facing perimeter wall
	Standing height horizontal surface	Working standing up	High table or bench top, mobile storage unit
	Low table	Working seated on floor	Low table e.g. coffee table height
	Low soft/comfortable seating	Working in a comfortable setting	Couch, beanbags, cushions, seating pads
	Stepped horizontal surfaces	Explicit teaching to a group, or independent individual or small group work	Tiered seating
	Moveable seating and work surfaces	Ability to easily change furniture settings to suit learning activities	Lightweight tables and chairs on castors or glides, ottomans, beanbags, cushions, seating pads
	Pivoting standing height horizontal surface	Ability to change between independent or group standing setting	Pivot bench
	Open shelves	Ability for students to access learning resources	Open shelves at accessible height for students
	Mobile resources storage	Ability to move learning resources where required	Mobile resources trolley
	Digital Technology		
	Device to project content to large screen	Sharing content	Projector, digital LCD screen
	Virtual workspace	Virtual collaboration	Cloud, WIFI
	PCs	Use of internet and computer software	Fixed computers and laptops
	Mobile large digital screen	Ability to move presentation screen where required	Computer on Wheels (COW)
	Retractable green screen	Ability to use as a background for filming	Green screen on retractable roll
	Digital touch tables	Collaboratively researching and sharing information	Digital touch tables
	3D printers	Ability to print 3D objects	3D printers
	Tablet devices	A mobile digital workspace	iPads
	Virtual Reality (VR) zone	Ability to explore ideas using VR technology	Zone defined for VR activities
people	**People**		
	Students	Working together and discussing ideas	Other students
	Teachers	Ability to support students in their learning	Teacher facilitators

There were other spatial qualities which participants also felt influenced student learning, however as these were not seen to directly afford teaching and learning activities they were not included in this listing. For example, these included:

- A mural on the wall of the Site 5 museum learning space which participants felt gave a sense of identity and energy, and therefore added to the experience of engagement within the space.
- Views to the outdoors and indoor plants providing users a connection to nature and therefore a sense of calm.
- Use of colour to promote a sense of character or feeling of liveliness or calm.
- Use of natural materials invoking a sense of calm.
- Museum objects promoting opportunities for student engagement.

Participants largely believed that these qualities were beneficial for influencing how people felt (i.e. calm or engaged) and therefore on their sense of well-being. In fact, two of the elements mentioned above, connection to the outdoors and to nature, has been correlated with many positive effects on students such as lower levels of stress (Wells & Evans, 2003), greater self-discipline (Taylor et al., 2001) and decrease in fatigue (Kaplan, 1995). Barrett, Zhang, et al. (2016) also positively related 'links-to-nature' to improved creative writing at primary school level. However, although aspects relating to 'links-to-nature' were viewed positively by participants, as they did not relate directly to action possibilities they were not included as part of the taxonomy of affordances.

Not surprisingly, participants did not identify the most basic affordances associated with all buildings e.g. roofs to provide shelter, or walls to protect from external disturbances such as noise.

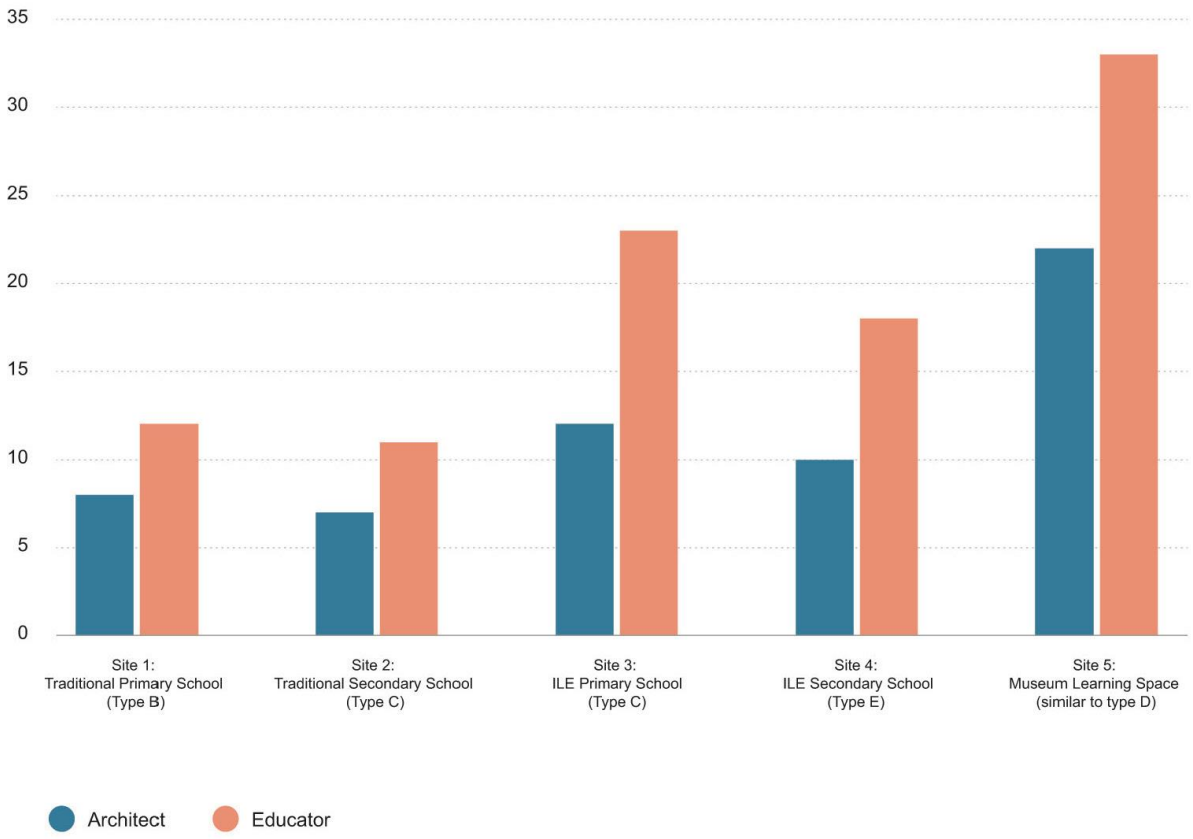
Affordances within learning space typologies

A clear distinction emerged from the analysis in relation to affordances perceived within different spatial typologies (Dovey & Fisher, 2014). Overall, more affordances were perceived by participants within ILEs than traditional classrooms. This variation in affordances between spaces of different typologies reflected both the physical features of the spaces as well as the practices (actions) known to take place within them. These findings suggest that more opportunities are afforded for learning activities in ILEs than in traditional

learning spaces (refer Figure 46) and reinforces the understanding that ILEs are designed with an intent to enable a wider range of pedagogies.

Figure 46

Number of affordances perceived by architects and educators at case study sites



Note: From Young et al. (2019, p. 710).

Traditional learning spaces. In the more traditional learning spaces (Sites 1 and 2), shared common areas such as the outdoor deck (refer Figure 17, Chapter 3) and foyer (refer Figure 20, Chapter 3) adjacent to classrooms were perceived favourably by educators for affording a range of teaching and learning opportunities not possible within classrooms. For example, the covered timber deck at Site 1 was considered a highly collaborative learning environment extending teaching and learning activities not possible within adjacent classrooms. Lessons of a collaborative nature regularly took place across the three-classrooms, timber deck and nearby outdoor areas. As noted by a Site 1 teacher "they're all

connected by the deck - so it's a very fluid space…it's easy to check in with each other…it's easy to do things collaboratively because the space is as it is (Teacher 1, Site 1).

The Site 1 participants acknowledged that whilst separated spaces constrained fluidity of connection between students and teachers, their philosophical position on the effectiveness of team-teaching 'forced them' to maximise the opportunities afforded by their spaces. In describing how they used their spaces to align with their pedagogical position, a teacher said "we have to use our deck and we have to use that corner and you're really forcing the constraints of the classroom space to match what you want to achieve" (Teacher 4, Site 1).

Despite the spatial constraints of cellular spaces, it was found that a key to enabling more collaborative approaches to teaching and learning was flexibility in practice. Because teachers at school A had flexibility in the way they worked, walls seem more porous than may have been perceived by others. A Site 1 teacher noted "It doesn't really constrain because…when there's flexibility…students will still go between spaces and find where they want to be working…I guess in that respect we've structured it so that it's not restricting" (Teacher 2, Site 1).

Few affordances were perceived in the Site 2 cellular classrooms (refer floor plan Figure 18, Chapter 3), however teachers noted that the 'homely' way in which the shared foyer space between classrooms had been set up afforded additional learning opportunities for quiet and reflective activities. In discussing the uses of the foyer space, Teacher 3 noted:

> It's set up as your lounge room, your safe area so it's also if students feel like they're having a bad time out in the playground, but it's also a discussion area as well where it's a bit more comfortable for them. If they're a bit anxious about the classroom environment, too many eyes, it's a smaller environment where it can just be them, the teacher, or two other students they feel comfortable with. It's the whole bringing the comforts of home into the classroom. (Teacher 7, Site 2)

The importance of having school spaces that evoked a sense of home was also noted by Lackney (2015a) who suggested that friendly and home-like features such as welcoming entry sequences and spaces that felt like living rooms could help reduce student anxiety about school.

Comfort was commonly discussed by participants across both professional groupings. Spatial qualities such as being smaller, texturally softer (e.g. upholstered or carpeted) and/or not noisy afforded a level of comfort for students to take time out and/or calm down. More generally, it was felt that qualities of comfortable spaces fostered a greater sense of belonging and ownership. Saltmarsh et al. (2015) also noted the importance of textural objects within

spaces such as floor rugs and comfortable seating to demarcate more intimate spaces for quiet activities such as reading.

Teachers at Site 2 considered the retractable wall between classrooms a constraint as these appeared to be permanently closed. As students in adjacent classrooms were regularly being taught the same content, teachers felt it was a missed opportunity to not be able to collaborate across classes. One teacher felt that the walls were not opened due to a perceived risk of 'losing control' with larger groups of students. He also felt that there was a lack of time made available for teachers to adequately prepare to teach collaboratively. As noted by a teacher:

> To team teach, to open up a space requires a lot of preparation on behalf of the teachers. So, given that everyone is so busy I don't think that that is a huge consideration even though it could potentially lead to better engagement if two classes are combined or the learning space was bigger. (Teacher 5, Site 2)

Despite opportunities for better engagement in learning, constraints around the need to prepare to teach in different ways such as lack of time may disable the potential of utilising affordances.

ILE spaces. Table 14 shows the distribution of affordances perceived across the various sites. Higher numbers of affordances were identified in the ILE spaces (sites 3-5) than in traditional locations. This resulted from a combination of:

- larger spaces
- more numerous well-defined zones
- spatial openness and vistas across learning spaces
- varied furniture, aiding the definition and differentiation of learning settings
- the capacity to change and/or reconfigure spaces to meet varied requirements
- access to a range of digital resources/technologies

Table 14

Affordances perceived by educators and architects at case study sites

space

Spatial Qualities	Affords	Feature/Element	Traditional		ILE		
			Secondary	Primary	Secondary	Primary	Museum
General							
A range of different settings	Different ways for students to work	Zones, furniture and surfaces					
Spaces that can changed for different uses	Ability to adapt space to suit learning activities	Moveable walls, mobile and agile furniture					
Spatial openness and vista	Visibility of students and teachers within a space	Higher ceilings, larger spaces, glazed screens					
Uncrowdedness/space to move	Ability to easily move around to different groups of students	Adequate space between furniture					
Natural light, ventilation, air temperature	Environmental comfort	Suitable floorplate depth, glazing, openable windows					
Zones							
Smaller defined areas	Small group, individual and independent work	Alcoves, recesses, nooks, booths					
Separable smaller space	Quiet individual activities, or small group activity	Breakout room with acoustic separation					
Large group area	Gathering large groups for explicit teaching	Area to fit large group areas (either seated or on floor)					
Outdoor learning spaces	Ability to extend learning activities to the outdoors	Outdoor decks or terraces adjacent to indoor spaces					
Spaces with a sink, durable floor covering	Ability for messy activities (making, doing, experimenting)	Wet area, Maker space, Laboratory					
Open floor space	Gathering large groups, or smaller group work	Area of open floor space for large or small groups					
Space for teachers to work together	Ability for teachers to collaborate and plan lessons	Teacher collaboration workzones					
Finishes/Fixtures							
Empty wall space (or pin board)	Display of learning protocols and/or student work	Vertical surface for pinboard and/or magnetic panels					
Wall that can be opened or closed	Ability to connect or separate spaces	Sliding, retractable or pivoting wall					
Writeable wall surface	A primary focal point to display information	Whiteboard or whiteboard wall surface					
More than one vertical writing/ projecting surface	Teaching to multiple groups in same space	Multiple whiteboards and/or projection/digital screens					
Writeable glazed surface	Definition of & visibility through space, and a writing surface	Glazed screen					
Large circular floor graphic	Demarcating activities/easily gathering groups of students	Floor markings defined by carpet or paint					
Retractable curtain	Darkening a space, and connecting or separating spaces	Curtain or blinds					

Table 2

(continued)

	Spatial Qualities	Affords	Feature/Element	Traditional		ILE		
				Secondary	Primary	Secondary	Primary	Museum
object	**Furniture**							
	Horizontal sitting and working surfaces	Working sitting down, on tall stools or standing up	Desks/tables, high tables, benches, seats, bar stools	Educator, Architect	Architect			
	Table height horizontal, round, flat surface	Facing other students for collaborative activities	Circular table				Educator	Educator, Architect
	Moveable seating and work surfaces	Ability to easily change furniture settings	Mobile tables & chairs, ottomans, beanbags, cushions		Educator	Educator, Architect	Educator, Architect	Educator, Architect
	Table height individual work surface	Independent work	Single desks or bench facing perimeter wall		Educator			
	Table height horizontal surface for 4-6 users	Ability to collaborate	Group table seating four to six people			Educator		Educator
	Table height horizontal writeable surface	Freedom for students to test ideas	Whiteboard table				Educator	Educator, Architect
	Standing height horizontal surface	Working standing up	High table or bench top, mobile storage unit			Educator	Educator	Educator
	Pivoting standing height horizontal surface	Ability to change between standing independent or group use	Pivot bench					Educator, Architect
	Low table	Working seated on floor	Low table e.g. coffee table height				Educator	
	Low soft/comfortable seating	Working in a comfortable setting, sitting on floor	Couch, beanbags, cushions,			Educator		
	Stepped horizontal surfaces	Explicit teaching or individual or small group work	Tiered seating				Educator	
	Open shelves	Ability for students to access learning resources	Open shelves at accessible height for students		Educator, Architect		Educator	Educator, Architect
	Moveable resources storage	Ability to move learning resources where required	Mobile resources trolley					Educator, Architect
	Digital Technology							
	Device to project content to large screen	Sharing content	Projector, digital LCD screens	Educator, Architect	Educator, Architect	Educator		Architect
	Virtual workspace	Virtual collaboration	Cloud, WIFI			Educator		
	PCs	Use of internet and computer software	Fixed computers and laptops			Educator		
	Mobile large digital screen	Ability to move presentation screen where required	Computer on Wheels (COW)				Educator, Architect	Educator
	Retractable green screen	Ability to use as a background for filming	Green screen on retractable roll					Educator, Architect
	Digital touch tables	Collaboratively researching and sharing information	Digital touch tables					Educator, Architect
	3D printers	Ability to print 3D objects	3D printers					Educator
	Tablet devices	A mobile digital workspace	iPads					Educator
	Virtual Reality (VR) zone	Ability to explore ideas using VR technology	Zone defined for VR activities					Educator, Architect
people	**People**							
	Students	Working together and discussing ideas	Other students	Educator	Educator	Educator		Educator
	Teachers	Ability to support students in their learning	Teacher facilitators					Educator

Educator Architect

In the primary school ILE (Site 3), participants perceived more affordances relating to ‘zones’ than in any of the other school case studies. Zones included a breakout room for smaller group activities, and a wet area and covered outdoor learning space affording the ability to enable messy or wet activities. In addition to this there was a small storage room located at either end of the primary ILE space (refer floor plan Figure 21, Chapter 3) which formed two recessed smaller zones in the main learning space on either side. These were used in a variety of different ways such as bag storage, reading corners (refer Figure 47), or quiet work zones (refer Figure 48).

The articulation of the walls within Site 3 offered more opportunities for teachers and students to work in diverse ways and contributed to the overall higher number of zones. This notion of ‘articulated’ classrooms enabling greater diversity of areas for teaching and learning over ‘unarticulated’ cellular classrooms was first identified by Herman Hertzberger (Hudson & White, 2019), who noted the need for “nooks and niches” to support more independent work. Hertzberger (2008) felt that “The more articulated or modelled a space is, the more possibilities for more differentiated learning it has to offer” (p. 24) (see Figure 49).

Figure 47

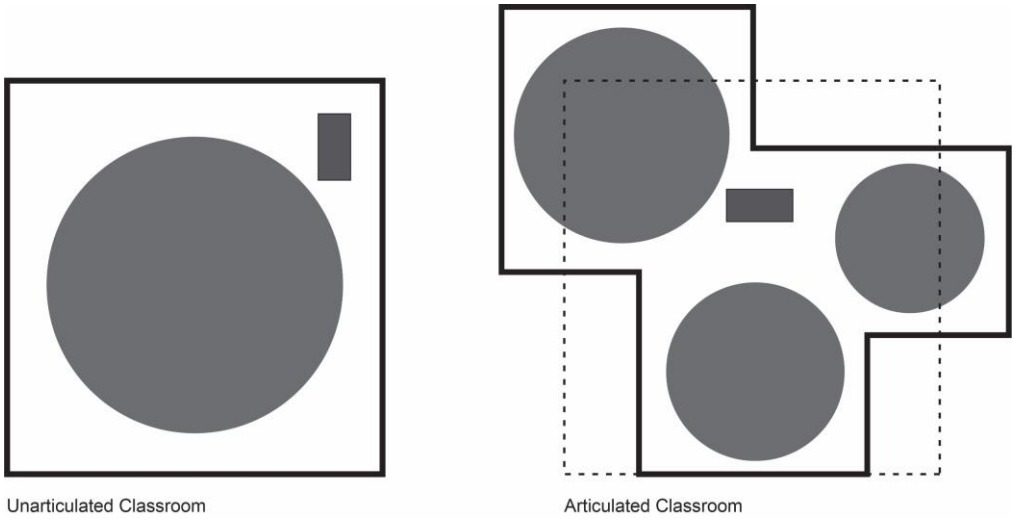
Articulated walls forming reading corner (Site 3)

Figure 48

Articulated walls forming quiet independent work area (Site 3)

Figure 49

Unarticulated and articulated classrooms



Note: From Hertzberger, H. (2008, p. 24)

The paired primary ILE classrooms had a central operable wall allowing the classrooms to be connected or separated. As the philosophy of the school was for all classes to be collaboratively taught by two teachers, all operable walls were fully open throughout the school. One teacher noted that whilst the panels were never closed, the retracted surface facing into the room provided a useful pin-up space to display student work (refer Figure 50). When retracted, the panels created additional alcoves creating more intimate zones for one to two students to work in (refer Figures 51 and 52). Interestingly, this was an affordance not noted by the architect who designed the space and is an example of an improvised affordance (Van Osch & Mendelson, 2011), perceived and recognised only by users through use of a space.

Figure 50

Operable wall in retracted position creating pin up space for student work (Site 3)

Figure 51

Operable wall in retracted position creating nook for students to work (Site 3)

Figure 52

Operable wall in retracted position creating nook for students to work (Site 3)

The secondary ILE learning space was a large ‘unarticulated’ (Hertzberger, 2008) rectilinear space, hence the shape of the space offered less zones than in the primary school (refer Figure 24, Chapter 3). Being larger than a typical classroom enabled adequate space for teachers and students from more than one class at a time to use it. Its size and high ceilings afforded a greater sense of openness enhancing both visibility across the space. This site was the only one which included a dedicated teacher work zone, the presence of which was found to enhance the practice of team teaching (refer Figure 26, Chapter 3). The teacher work zone was a recessed workspace shared by four teachers connected and open to the main learning area. Visibility from their desks to the learning space enabled teachers to observe and learn from each other’s practice.

Visual connections both within and between learning spaces was considered a useful affordance for teaching and learning. Larger volumes, higher ceilings and glazed screens allowed visibility for teachers to more easily keep track of students working in different zones. Visibility between separate spaces (via full-height glass walls) (refer Figure 22, Chapter 3) enabled students and teachers to observe each other’s practices and settings. It was felt that seeing other spaces could in turn stimulate teachers and students to think about how their own learning settings could evolve.

Whilst primary and secondary school ILE spaces were distinctly different from each other, in both cases they were larger than a typical classroom and contained a diverse suite of furniture types. Participants identified furniture as by far the largest family of affordances across ILE spaces. This thematic ‘parent group’ included (refer Figure 53):

- mobile furniture affording the ability to reconfigure spaces for different activities.
- circular tables (both sitting and kneeling heights) affording enhanced collaboration.
- standing tables or joinery affording the ability to work whilst standing up.
- whiteboard surfaces on tables, walls and storage units affording sharing ideas, testing and brainstorming.
- stackable cushions, affording sitting (or lying) on the floor in different arrangements.
- accessible storage for learning resources affording ready access for students and teachers.

Figure 53

Furniture affordances in ILE spaces (Sites 3 and 5)

These are similar to some of the affordances perceived in ILE spaces by Cleveland (2011), who identified the size and scale of learning spaces, varied learning settings, effective circulation, furniture, technology, storage, display, acoustics, light and visual connection as key design considerations for ILEs. His more recent work with colleagues also identified an expanded set of 18 variables (Cleveland et al., 2018, p. 6) that may be employed to evaluate learning environments from a pedagogical perspective. These variables included (Cleveland et al., 2018, p. 6):

- Geographical engagement
- Size and scale
- Activity settings
- Furniture

- Opportunities for agile and flexible use
- Provision and access to resources
- Movement of people and objects
- Provision and use of display space
- Character and aesthetics
- Accessibility
- Security
- Student toilets
- Occupant comfort (acoustics, thermal and air quality, lighting)
- Staff professional development and teaching support spaces

Museum learning space. The museum learning space (Site 5) had the most perceived affordances of all the sites. Similar to the primary school ILE, there were a high number of zones articulated by walls, screens or joinery. However, there was also a greater diversity of furniture and digital resources/technologies. Technologies have also been identified as a useful affordance for learning by other researchers including Lomas and Oblinger (2006). At the museum site, technologies included access to Wi-Fi, mobile devices, green screens, 3D printers and virtual reality resources.

Secondary schools vs primary schools. Across both traditional and ILE schools, slightly higher numbers of affordances were perceived in primary schools over secondary schools. In the traditional schools this partially related to pedagogical differences. For example, whilst primary school desks were not designed to be mobile, because of their relatively small size educators felt that they were easily moveable to enable different settings, such as independent learning and group learning areas. Moving desks also created the ability to have open floor space which was perceived to be a useful affordance for collaborative learning. At secondary level, the tables were also not designed for ease of mobility however this was perceived as a barrier to enabling more diversity in learning settings.

In the ILE secondary school, participants perceived more affordances in general and digital technology categories. However, a lower number of affordances were identified in relation to zones, finishes and fixtures, and furniture. Although there was a wide range of furniture in the secondary school ILE space, the lack of articulated zones such as smaller spaces, enclosable spaces or wet areas reduced the number of overall affordances perceived.

Outdoor spaces. Three of the sites had direct access to covered outdoor learning spaces. Participants felt that using spaces beyond the classroom enabled a greater range of learning activities. This included activities that were louder, required more space, related to environmental or outdoor contexts, or involved sport or movement. Having glazed visual connections between these inside and outside spaces also enabled teachers to see students working outside, eliminating the need to schedule regular trips back-and-forth to check on students.

At Site 1 there were two single panel swing doors connecting to the deck at either end of the classroom (refer Figure 54). Although the two openings from the classroom to the outdoor space provided access, an architect participant noted that more generous-sized doors would offer better accessibility and facilitate better opportunities for outdoor learning. This was evidenced at Site 3 where there were large glazed sliding doors from the classroom to an outdoor terrace affording excellent access and visibility between inside and outside (refer Figure 55). Teachers noted that the width of the sliding doors enabled mobile furniture to be easily moved outside and being able to keep this door open was beneficial to allow fresh air into the classroom.

Whilst outdoor learning spaces were found to afford opportunities for interdisciplinary learning in this study, Young and Murray (2017) identified their potential for playful approaches to learning. In their study, a high proportion of teachers felt that outdoor spaces *could* be used to support playful learning, however as teachers were reluctant to teach outside of classrooms it was rarely done. This may relate to the earlier comment relating to constraints around time to consider teaching in different ways. Given the additional opportunities for learning offered by outdoor spaces and benefits of "links-to-nature" such as lower stress levels and higher levels of creativity in writing (Barrett, Davies, et al., 2016), further research could explore how to better enable outdoor learning environment affordances through design and practice.

Figure 54

View from Site 1 classroom to deck showing two doors either end of the room

Figure 55

Site 3 sliding door access between indoor and outdoor learning spaces

Note: Image courtesy of Guy Wilkinson Photography.

Environmental graphics. Two of the sites incorporated large graphics on the floor. The circle on the floor of the museum learning space was known as ‘The Dot’ (Figure 56) and was specifically designed to demarcate where virtual reality (VR) activities took place. This was considered a safety measure as when students are wearing VR headsets, they are unable to see the ‘real’ physical context around them and can easily bump into other students. For students not wearing headsets during VR activity, the Dot provided visual cues to stay out of the circle, reducing the likelihood of accidents. The circular graphic was also identified as an effective tool to efficiently gathering large groups of students together. A visiting teacher participant noted “when you’re a teacher and you know how long it takes for kids to sit in a circle, just having a patch of carpet like that laid out straight away saves about 5 minutes” (Teacher 4, Site 5). The large circular graphic on the outdoor terrace of the ILE primary school (Figure 57) similarly offered visual cues to gather groups or demarcate zones for learning activities.

Figure 56

The Dot (Site 5)

Figure 57

Circular graphic in covered outdoor learning zone (Site 3)

Affordances relative to teaching and learning approaches

Some affordances were perceived to better support particular approaches to teaching and learning over others. Affordances perceived in support of deep learning, collaborative learning, team teaching, and interdisciplinary learning are shown in Table 15. Generally, educators and architects felt that having a range of learning settings enabling different ways for students to work was of high importance across all teaching and learning approaches.

Both professional groups felt that larger learning spaces that enabled more than one class to work together and dedicated space for teachers to collaboratively plan lessons was important for supporting team teaching. These spatial qualities meant that even if teachers hadn't specifically planned to teach a lesson together, by having space they could be in at the same time they could informally learn from and support each other. A Site 5 teacher described how the openness and size of learning spaces at his school supported a culture of teacher collaboration:

> When you're teaching there's at least one teacher opposite you teaching and you're observing each other. You're actually supporting each other even though you maybe don't do anything with each other. There's always people in the offices that can hear what you're doing. Mostly they try to ignore what you're doing because they're doing work, but there's the notion that teaching isn't a private activity…there's that culture of 'all in

> together' and all working together for the same thing. And you're learning from each other, you're supporting each other without even really thinking about it. (Teacher 16, Site 4)

As well as larger spaces, it was found that having a sink and durable floor coverings suitable for wet and/or messy activities was also considered important for interdisciplinary learning. Areas that had these qualities included art/science zones, maker spaces and outdoor learning spaces. Equally important was having spaces that could be easily reconfigured or used in different ways to allow co-location or merging of activities and digital resources to explore ideas in different ways. A secondary teacher noted that the qualities of the larger and connected ILE space he worked in very much enabled interdisciplinary approaches:

> Not only is it the two teachers that maybe are running that session, there's your other teacher that you've had for another session that's in their pod and you can just go and ask for help. Or there's another group that are working over in another session you can go and cross over and check with. I think interdisciplinary learning and the skill sets of different teachers lends itself to this space. (Teacher 13, Site 4)

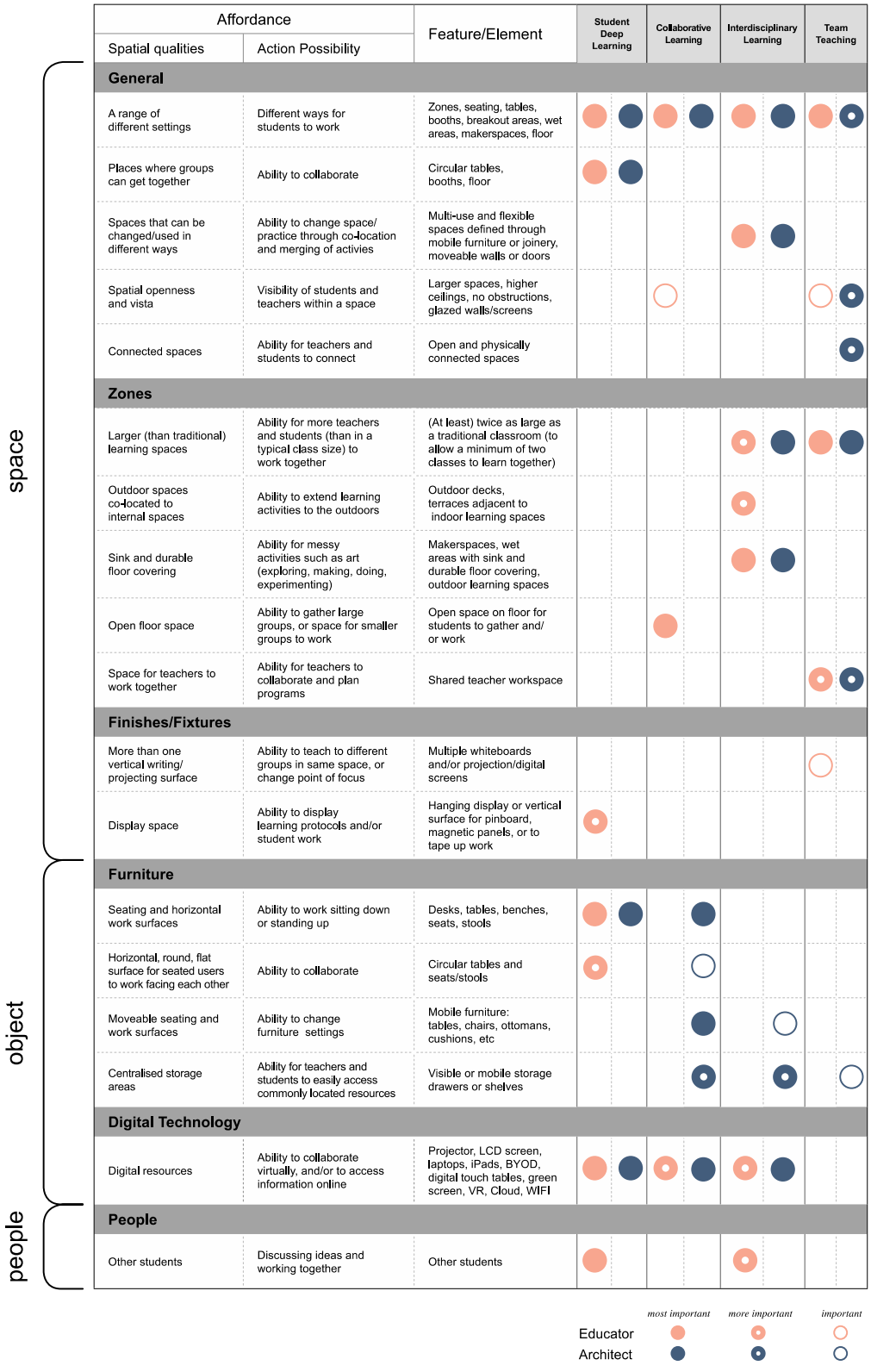
Whilst it was possible to enable a range of learning settings and teaching approaches in both traditional and ILE spaces, traditional sized classrooms were perceived to be too small to support team teaching or interdisciplinary learning activities. Larger spaces, more numerous learning settings, openness that allows visibility and movement, and dedicated teacher spaces more characteristic of ILEs were seen to better support team teaching.

Few additional elements beyond "having a range of different settings enabling students to work together in different ways" were identified by participants in relation to collaborative learning as the parent affordance encompassed many sub-categories. Digital resources, however, were pointed out as beneficial for virtual collaboration. Teachers also recognised open floor space as an important quality for collaborative learning as students at both primary and secondary level often like to work in groups on the floor.

Affordances that best supported deep learning were similar to those that supported collaborative learning. Teachers described the importance of informal conversations between students to help build deeper understandings of concepts. It was felt that when students were able to articulate their thoughts with each other, they were better able to understand and evolve concepts to a deeper level. In discussing deep learning conversations, a teacher noted "the language that they're using is perfectly pitched to their level and they can explain it to each other and…make those connections amongst each other better than what I can deliver to them" (Teacher 12, Site 3).

Table 15

Taxonomy of affordances perceived by educators and architects relative to teaching and learning approaches



Note: From Young et al. (2019, p. 715).

Affordances important for deep learning included places where groups can get together enabling the ability to collaborate, digital resources for virtual collaboration, and having a range of furniture to enable different ways of working. Group tables were seen to be valuable for deep learning as conveyed by this teacher:

> When you hear the conversations…on a learning task they just take it to another level sometimes that you don't get in a teacher environment. I think the fact that these little sharing tables can work together in a little group, a cluster like that is great because they can feed ideas off each other and the child that needs extra help is often supported by those other pupils that have more knowledge. And it's not coming from the teacher and so therefore the meaning is a bit more purposeful to them. (Teacher 20, Site 5)

Different furniture types were identified as useful to enable a wider range of activities. This was also found by Morris and Imms (2020, November 19) who noted that flexible furniture gave "students more autonomy to be active learners, participating in collaboration with peers or leading their own work". In their study, they found that in traditional classroom arrangements teachers spent more time engaging with whole class direct instruction, however "when flexible furniture was available, they gave instructions to smaller groups, making it easier to tailor specific tasks to students and help those who may need it".

In relation to deep learning, educators recognised tables with rounded corners, such as round or 'racetrack' shaped tables that seated between 6-8 students, as particularly beneficial for collaborative discussions that led to deep learning outcomes. Participants felt that the curved convex shapes meant that students all faced towards each other, improving ability for eye-contact and to converse and collaborate.

Affordances and the spatial characteristics of playful learning. Learning environment affordances that supported deep learning approaches identified from this study are similar to qualities of space that Young and Murray (2017) found that supported playful approaches to learning. Many of the spatial characteristics identified by Young and Murray's (2017) study are represented in the taxonomy of learning environment affordances (Table 15) identified as important for team teaching and collaborative, interdisciplinary and deep learning. This alignment may be unsurprising given the increasing awareness and research into the benefits of play, and relationship to deep learning skills (Parker & Thomsen, 2019; Sahlberg & Doyle, 2019; Strommen & Lincoln, 1992).

Young and Murray's (2017) study identified teacher's attitudes and approaches to lessons and use of learning spaces as critical to enabling playful approaches to learning.

However, little research exists on spaces that support playful approaches to learning at school or practices which activate these. As a concept bridging space and use, the lens of affordances could offer a useful vehicle to provide further insight into spaces for playful learning and how to enable these.

The varying perceptions of architects and educators

As shown earlier in Figure 46, the numbers of affordances perceived by educators and architects across the case studies varied. Across all sites, architects perceived fewer affordances than educators. As a group, architects mainly noticed higher order 'parent' affordances, more so than 'nested' affordances. For example, architects generally noted that ILE spaces had 'a range of different settings', rather than point out specific qualities included in the range. In comparison, educators frequently perceived both 'parent' and 'nested' (Gaver, 1991) affordances, highlighting their more detailed understanding of the activities common to these spaces. This is best exemplified by these two different professional perspectives of the same traditional primary school learning space. Here is Architect B's perception of the learning environment at Site 1:

> It's pretty typical of most of the classrooms I see. It's an absolutely traditional size and shape. It's a prefab type building. It's got some hard floor for wet areas, the rest of it is soft floor, a bit of technology, a projector. The layout is absolutely standard. (Architect B, Site 1)

Here is Teacher 3's description of the same site which provides a much richer account of the possibilities of the space:

> There's spots for kids to be facing each other and working … there's options for independent learning spaces where they can maybe close themselves off from any distractions … there's different levels for being on their knees or at a desk or down on somewhere comfy … you've got current learning walls with student input … there's obviously no name tags on any of the chairs so it's quite flexible where the kids can choose where to sit and that can obviously change from moment to moment or from day to day so they've got choice in where they work. (Teacher 3, Site 1)

These observations align with the views of Koutamanis (2006), who suggested that due to the complexity of human activities that are better known to inhabitants, architects are commonly less successful at sharply defining functions within the built environment.

Open floor space. While most educators identified the importance of open floor area as an affordance for learning, none of the designers recognised the same affordance. Action possibilities included enabling more flexible furniture arrangements and promoting teacher movement between student groups. At both primary and secondary level, it was seen to afford groups, both large and small, to come together for varied activities. In describing the benefits of open floor space for collaboration, a primary teacher noted "it's quite a social space… Anything they're working collaboratively on they prefer to be on the floor" (Teacher 20, Site 5). A secondary teacher also pointed out the value of floor space for discussion: "I think having that extra room, where you don't have to be sat in that traditional sort of sense helps with the collaborative learning and allows it to be more open for discussion" (Teacher 7, Site 2).

For designers who may not be conscious that the floor is such a useful affordance for learning, these understandings are significant. In the process of school design, furniture procurement is commonly determined by class capacity. Room layouts generally show how different furniture items fit or even 'fill' a room, rather than ensuring adequate areas of open floor space remain for student activities. Better recognition by designers of the floor as an affordance could influence design decisions around the quantity of furniture required in a room, flooring materials, or furnishings such as floor rugs, cushions or low height tables.

Other students. Teachers identified the presence of other students to discuss ideas with as an important affordance for deep learning. However, this affordance was not mentioned by architects at all. Educators at most of the case study sites specifically noted other students was a critical affordance for deep learning. This suggests a difference in perception around how the two professions think about the environment.

In relation to this insight, it is interesting to consider the nature of architectural representations of space and buildings. Wilks (2009) states, "the vocabulary and ways of representation used by architects, facilities experts, acoustic engineers and builders are foreign for teachers and vice versa". Similarly, Newton (2009) suggests that "not only is much of the terminology being used incomprehensible, but the abstract plans and elevations may not be easily understood by those outside the design and construction disciplines." As the interaction of students is of primary importance to educators, and a lens which resonates for them, perhaps architects need to consider this in their representations of school design. In order to ensure design ideas are adequately communicated to clients and end users about *how*

proposed spaces can be used, perhaps architects need to find ways to represent human life and activities in architectural representations?

Whiteboard surfaces. Both architects and educators recognised whiteboard surfaces as a spatial quality for learning, however, teachers spoke effusively and with much more nuance about their benefits. Vertical whiteboard surfaces allowed students to see content and be reminded of ideas that had been previously discussed. They were identified as a spatial quality that enabled collaborative work and offered opportunities for students to brainstorm and write up ideas together. When students used vertical whiteboard surfaces, teachers felt that the divide between teacher and student was diminished, enhancing greater sense of ownership of learning spaces.

The impermanent surfaces of whiteboard tables were found to be particularly useful for primary school students who were often fearful of making mistakes. These surfaces also allowed teachers to provide quick written notes or guidance to help students complete tasks. A primary teacher noted that there were so many uses of whiteboard tables that she had never considered earlier. She said, “when we first got them it was like “yeah cool you can write on them”, but they've now become the most invaluable teaching tools” (Teacher 12, Site 3). She describes some of the uses as follows:

> I've got a lot of kids who are quite nervous about committing something to paper for fear of getting it wrong…or just not sure what to do. So…writing on the whiteboard can so easily be rubbed off…it gives that instant working space for maths or even for spelling out a word. They can sort of check it a couple of times on the whiteboard first, quickly rub it out and then transfer it over to their work…and you can write reminders as well. So, I have a couple of kids who find it difficult to stay on task, so I can go and sequence the daily activity...and they can tick that off as they go, or they can physically rub that out and see that progress. (Teacher 12, Site 3)

These examples offer designers useful insights on the importance of surfaces for learning. Finishes selected in the design of learning spaces can be considered not just for how they look or feel, but also for the action possibilities they offer for learning.

Hierarchy. When ranking affordances for deep learning, the perceptions of architects and educators varied quite significantly. Architects rated natural light, ventilation, air temperature and acoustics as the most important (baseline) spatial qualities. Although teachers also valued these qualities, most felt settings where students could gather, access resources, and be reconfigured for multiple uses were most important for learning. Table 16 outlines the hierarchy of spatial qualities that were found to enable and constrain deep learning.

Table 16

Hierarchy of spatial qualities enabling and constraining deep learning

	Enablers		Constraints	
	Architects	Educators	Architects	Educators
most important	Natural light, ventilation and air temperature	Places where groups can get together	Size of (traditional) learning spaces	Size of (traditional) learning spaces
	Sound absorption			
	A range of different settings	Digital resources	Lack of sound absorption	Lack of sound absorption
	Spaces that can be changed or used in different ways	Spaces that can be changed or used in different ways		
	Seating and horizontal work surfaces			
more important		Larger (than traditional) learning spaces.	Not having connected spaces	Lack of smaller defined areas
		Table height horizontal round flat surface		
		Smaller defined areas	Lack of, or ineffective digital resources	Having only one writeable/ projection surface
		Outdoor spaces		
		Natural light, ventilation and air temperature		
important			Lack of accessible resources	Lack of diversity in furniture
			Lack of smaller defined areas	
			Lack of diversity in furniture	
			Having only one writeable/ projection surface	

Note: From Young et al. (2019, p. 712).

The differing professional perspectives are curious and may highlight the relative influence architects and teachers have in enabling affordances. Architects are trained to design spaces with good indoor environmental quality (natural light, air quality, temperature and acoustics) while educators expertise focusses more on managing students' social organisation and the provision of learning resources.

The two professions are most aligned when discussing constraints for deep learning (refer Table 16). Both practitioners felt that the size of traditional classrooms constrained the ability for teachers and students to engage in collaborative teaching and learning activities and that larger spaces were required. They also felt that poor acoustics inhibited teaching and learning, particularly in relation to more diverse teaching practices such as collaborative learning.

It is interesting to note however that aspects that rated highly as a constraint did not necessarily feature as a critical enabler. For example, whilst both professions felt that traditional sized learning spaces were a constraint, only educators noted that having larger than traditional learning spaces was an important spatial quality to enable learning activities and behaviours.

Acoustics. Similarly, in relation to noise, whilst both professions recognised poor acoustics as a constraint, only architects rated it as one of the most important affordances for learning (see Table 16). Teachers did not independently identify acoustics as a necessary affordance at all. This may be explained by the different understandings between architects and educators around sound, noise and acoustics. Lackney (2008, p. 136) felt that in relation to acoustics, "rather than modify their physical environment to decrease unwanted visual and auditory distractions, teachers instead adjust their curricular activities providing evidence of a lack of understanding of spatial cause".

In describing constraints around the ability to hear, architects used the term 'acoustics', primarily referring to sound absorption, or surface treatments to reduce sound, improve clarity of speech and limit sound spread. Educators did not use the term acoustics but talked about 'noise' and the range of ways they addressed this as an issue. These included 'getting used to' the noise associated with students engaged in more collaborative modes of learning, allowing students to wear headphones to block out noise, and adapting their own practice. A primary teacher described how she adjusted to elevated sound levels within ILEs:

> You've got 60 kids and four teachers all trying to deliver instruction and especially when you've got kids who are easily distracted the noise can become an issue…There can be another lesson going on in the other half of the room that I can now pretend isn't there. I can shut it out a little bit easier than I used to and I think the kids get really good at doing it as well, but at the beginning of the year they were very easily distracted by any other noise going on. But you know if they're engaged and on task it shouldn't be too much drama. (Teacher 12, Site 3)

Some teachers discussed the need to adjust their teaching practices in larger and more open spaces to better capture student attention. A teacher at the ILE secondary school discussed how they had observed a correlation between the proximity of students to the teacher and the amount of attention paid to lessons. They noticed that students sitting up close paid attention, however students sitting a long way from the teacher would be "on their phone, on their computer, checking Facebook or whatever, reading emails" (Teacher 16, Site 4). Learning from this observation, the teacher adjusted his practice to get students to move closer to a "teaching wall" for moments of direct instruction which improved audibility and reduced likelihood of distraction. He noted:

> So, for my teaching I always make sure if I want kids to pay attention come up close…I've arranged the furniture so that I can say to kids "I want to talk to you as a group. Come together and sit together" and so then they focus on the board. And so "Okay I've finished. Any questions? No? Okay you can go off now and sit wherever you want and do your work"…You've got to make those conscious efforts. (Teacher 16, Site 4)

Another approach to blocking out unwanted noise and reduce distraction in larger learning spaces was to allow students to wear headphones when working autonomously. A teacher from the same school felt that it was about learning how to best manage different learning contexts and maximising "the resources of each other and teachers in this sort of space" (Teacher 13, Site 4).

Interestingly, in Site 2, there was a distinction between teachers' perceptions of sound emanating from another room (addressed via sound insulation) and elevated noise levels from the space they were using (addressed via sound absorption). At this site, as a result of the lightweight retractable wall divider, activity from the adjacent classroom was highly audible. Architect participants noted the lack of sound insulation between spaces as a constraint however this issue was never raised by teachers. When the noise was mentioned to teachers, all of them spoke positively about the presence of the sounds of neighbouring classes, and that hearing others engaged in learning was more natural and comfortable than having complete silence. These findings allude to the need for further investigations into educators' perceptions around sound, and for better understanding around teacher and student behaviours influencing sound quality within ILE spaces.

Conclusion

In order to explore ideas around how to support teachers to use the affordances of ILEs, it is necessary to first understand what the affordances of ILEs might be. The questions "What are learning environment affordances?" and "How are they perceived by educators and architects?" was addressed as part of Study 1 and are discussed in this chapter. This study aimed to gain insights into the types of affordances people (architects and educators) perceive in learning spaces. In total, 43 affordances were identified relating to six categories of general, zones, finishes/fixtures, furniture, digital technology and people. A brief taxonomy of affordances for learning (see Table 13) and insights into spatial qualities best suited to specific pedagogical approaches (see Table 15) resulted from this study.

Given the unique nature of affordances relating to an individual's abilities to perceive them, with a wider range of participants it is likely to have been possible to develop an even more comprehensive taxonomy of learning environment affordances. As ILEs are designed to be student-centred, actively seeking to empower students in the use of space for learning, the perspective of students could bring yet another dimension to affordances. However, the taxonomy of affordances discussed in this chapter provides a good starting point from which to understand potential action possibilities for learning.

It was apparent from the study that whilst there were some commonalities between the perceptions of architects and educators, there were also significant differences. These differing perspectives highlighted the potential for a gap in communication between architects' and educators' understandings of how spaces can support learning. This study revealed that although architects take carriage of the design of the physical environment of schools, educators perceived more detailed affordances than architects. Koutamanis (2006) attributes these deeper insights to a better understanding of the complexity of how environments are actually used in practice. The differing perspectives of designers and users highlight the importance of design processes which engage with teachers, students and other learning space users to ensure that the types of action possibilities that are desired and required are designed into new learning spaces.

From this study, affordances only picked up by educators offer a valuable insight for architects involved in learning space design. Open floor space was seen to support a range of collaborative learning activities. Recognising affordances for learning offered by the floor may influence designer's decisions around the selection of floor finishes and furnishings to better accommodate students in using this surface.

Similarly, greater consciousness around the importance of the social component of learning could influence decisions made around the development of learning settings for collaborative and deep learning. The recognition by educators-only about other students as a key affordance for deep learning also provides valuable insights for architects when considering how design is best communicated. As architectural drawings generally only show elements of the 'built' environment, the potential activities enabled by the spatial context and other people may not be recognised by non-designers. If architects aspire for their clients and end users to be able to 'see' the learning opportunities offered by the built environment of schools, then perhaps human life and activities needs to be illustrated in architectural representations to help teachers more easily recognise how spaces might support student interaction.

For schools wanting to enable team teaching, the size and cellular nature of classrooms can make this challenging. This aligns with Nair (2014), who noted that opportunities for interdisciplinary practices are enhanced when school spaces enable teachers to engage in collaborative teaching. However, this can be difficult with traditional school designs where "egg-crate" classrooms are more likely to promote teacher isolation. This study highlighted the value of larger ILE spaces towards supporting more collaborative teaching and learning activities. However, with larger spaces and more collaborative pedagogical practices, acoustics was recognised as a constraint for learning. Further research should investigate architects' and users' understandings and approaches in relation to noise, sound and acoustics in the design and use of learning environments.

This study also revealed an alignment between affordances that supported collaborative, interdisciplinary and deep learning with characteristics of space that enhance playful approaches to learning (Young & Murray, 2017). Although spaces such as outdoor environments might have the potential to support interdisciplinary and playful learning, Young and Murray's (2017) study showed that teachers' attitudes and approaches to lessons was a critical enabler for these spaces to be actually used in practice. Constraints such as time were found to influence the ability for teachers to utilise affordances. Initial insights from this study suggest that actualisation (or use) of affordances is influenced not only by features of physical environments, but also by the complex practices, activities and behaviours of teachers and students within these spaces. This will be explored further in Chapters 5 and 6.

Chapter 5. Utilising the Affordances of New Learning Spaces: Identifying Enablers

Introduction

This chapter discusses the contexts and initiatives which have helped teachers perceive and use the affordances of new types of learning spaces. It responds to the research question, *What factors enable teachers to actualise the affordances of learning environments?*

The findings are derived from Study 1, extending those reported and discussed in Chapter 4. This chapter offers deeper insights into teacher's perceptions of affordances and what enabled them to recognise the action possibilities of their school environments.

The twenty teachers from Study 1 were interviewed to find out what factors had enabled them to recognise and use the affordances of new learning spaces. Teachers were from primary, intermediate and secondary schools, as well as a dedicated museum learning space. The two museum educators were trained teachers and had taught previously in schools. Participants identified a range of formal and informal factors they felt had influenced their understandings, perceptions and use of space.

As described in Chapter 3, interviews were audio recorded, transcribed and then coded using thematic analysis (Braun & Clarke, 2006). An initial series of themes emerged from the coding process. These related to:

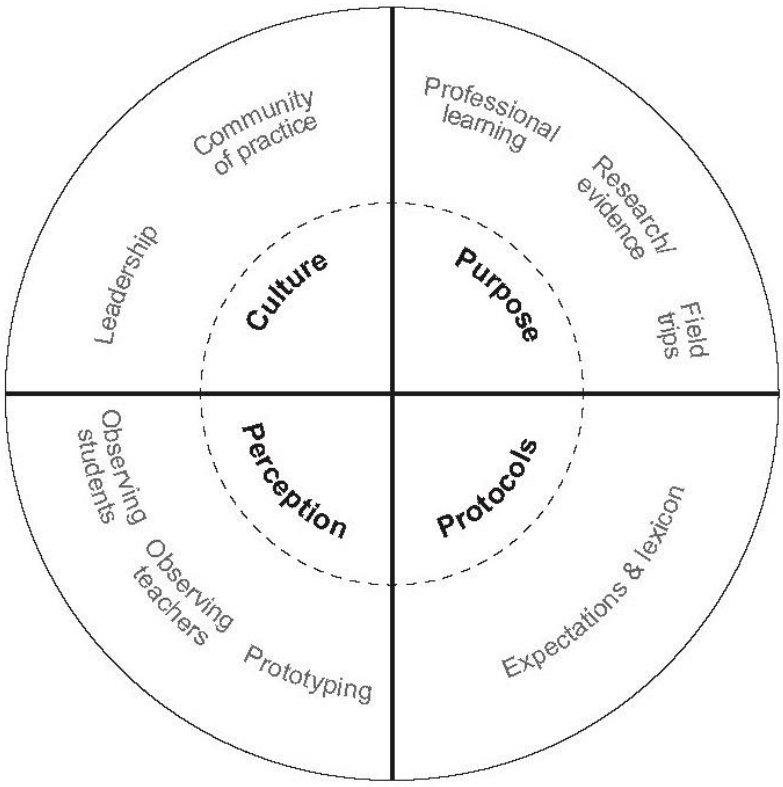
- school culture
- recognition of purpose associated with the need to change practice
- enhancing perceptions of affordances
- trialling and testing new ways of working

Further refinement of these categories led to the identification of four key themes that encapsulated the high-level factors found to underpin teachers' recognition and use of space:

- culture
- purpose
- perceptions
- protocols (see Figure 58)

Figure 58

Contexts and initiatives enabling affordance actualisation by teachers



Culture reflected high level aspects that were found to be foundational to enabling teachers to engage with processes of change linked with actualising ILE affordances. For example, the role of school leaders was considered critical to creating a fertile environment for teachers to evolve their current practices. Supportive leadership was seen to empower teachers with a sense of permission to explore broader pedagogical activities.

Purpose related to contexts where teachers learnt to recognise the value of ILEs in support of deeper student learning. When teachers had access to research and evidence about the benefits of new spaces and pedagogical opportunities, or they had opportunities to see other innovative spaces in operation, it helped shape their awareness of space as a resource for their teaching practice. Recognising the value of ILEs helped teachers gain a greater sense of purpose though which to engage in the process of learning new ways to work.

Perception involved contexts where teachers had gained greater consciousness of how to use different spaces. These examples involved teachers connecting and collaborating with each other to experience new teaching practices in practical and hands-on ways. In this way,

teachers learnt about new affordances by observing others use of space and having opportunities to share their own experiences.

Protocols related to the need to develop ways to align teacher's expectations about how spaces could be used. This included the development of a common lexicon to discuss affordances for learning.

Many participants recognised that earlier in their careers they believed that teaching was a teacher-directed activity. Most teachers had predominantly taught in single-cell classrooms with little interaction with other teachers during class time. Many also felt a level of self-consciousness about how others viewed their practice. Reflecting on their earlier experiences, a teacher noted, "having the principal come visit or another teacher come in, I was very conscious of what my learners were doing and where they were … I thought everyone should be sitting down, it should be quiet" (Teacher 18, Site 5).

However, understandings of the pedagogical opportunities offered by space appeared to evolve as teachers became more experienced in their practice. The shaping of teacher's abilities to practice in new ways enabled them to take advantage of the affordances offered by the environment. Another teacher noted:

> I've taught in this classroom quite a lot and I've used this space in a number of different ways that have changed as I've developed as a teacher. The space itself has changed occasionally but I've changed more and that's reflected in my use of the space as well. (Teacher 5, Site 4)

These insights provide some useful context to understand the challenges teachers face in evolving their practice within ILEs and the need for strategies to support this process. Below, I report my findings and discuss them in relation to the literature in sections headed by the four key themes that emerged from my analysis: culture, purpose, perception and protocols. Within each section, I elaborate on the sub-themes shown in Figure 58 (above).

Culture

Foundational to every organisation is their culture. Cultural contexts shape the expectations and norms of users, directing the way in which 'things are done'. As Osborne (2018, p. 10) puts it, "no matter how well planned and executed a change (or any other) strategy is, the culture of the organisation will determine whether a change is adopted, adapted or abandoned".

Within schools, it can be challenging for teachers to move beyond traditional pedagogies, however aspects relating to school culture were seen to enable or constrain teacher's abilities to practice in different ways within new spaces. Participants felt that having an encouraging and supportive social climate that was enabled by good leadership was essential to successfully transitioning to ILEs. It was also important for teachers to work as part of a community of practice (Lave & Wenger, 1991; Wenger-Trayner & Wenger-Trayner, 2015) with shared values and common goals around the use of space.

Leadership

Reflecting upon varying experiences of teaching in new spaces, participants noted that appetite for change varied amongst teachers and that shifting patterns of behaviour could be challenging. It was felt that having to work in different ways could lead to resistance by some teachers, therefore it was important to strategise change processes to mitigate this. This required strong leadership to champion the process of developing and supporting transitions to new learning spaces. Leaders required vision and direction. However, as a teacher noted, it was also important to engage staff "to get a bit of 'buy in'… because you get resistance along the way" (Teacher 20, Site 5).

Schools are highly scheduled, with timetables dictating what teachers teach, when they teach and where. It was felt that given the time constraints of a highly scheduled profession, teachers tended to make do with spaces they were given without feeling that they were in a position to question otherwise. An example of this was from Site 4 where there was a retractable wall between adjacent classrooms which could allow two adjoining spaces to either be separated or connected. This wall was never opened, evidenced by posters positioned across the wall's joins (refer Figure 59).

Figure 59

Retractable wall at Site 4

Teachers who taught in this space felt that being able to open the wall would allow better opportunities for collaboration between the two classes. However, the status quo at this school was for singular classroom instruction, hence the question of whether the wall could be opened had never really been broached.

It was felt that teachers needed to be better empowered to take advantage of the affordances offered by their learning spaces. One teacher noted that in schools, a sense of permission was required for teachers to feel that they could vary from conventional patterns. He noted:

> We teachers are fairly conservative people … we often don't give ourselves permission to do things. It's that notion of you feel you're allowed to do these things. Once you've got that notion then a lot of things become possible. (Teacher 16, Site 4)

These findings resonate with a study by Mackey et al. (2018) which found that "teachers feel empowered and enabled when leadership, and especially the principal, champion the vision for co-teaching in a flexible learning space" (p. 474). They also noted that school leadership

was rated by the majority of their participants as “important” or “very important” in relation to transitioning to flexible learning spaces.

It was felt that school leaders needed to explicitly give teachers permission to more actively curate their learning spaces to support optimal learning outcomes. Having leaders that encouraged and gave teachers time to trial new practices within ILE spaces was thought to empower teachers with the agency to shift from the ‘status quo’ of traditional teaching practices. In promoting more collaborative teaching cultures, Fullan (1990) also noted the importance of school leadership where “active encouragement from superordinates” (Wallace, 1999, p. 76) was needed.

This study found it was helpful for schools to be clear about their values and aims in relation to learning spaces and provide teachers time to learn to test new practices and to share their experiences with other teachers.

Articulating values around pedagogy and space may also have flow-on-effects with the wider school community. It was noted by a teacher that not only was it helpful to have the support of school leadership to try new things, but that parents also enabled or constrained teacher’s abilities to experiment with teaching practices and spaces. In discussing innovative practices one teacher noted “whenever a teacher gets the guts to implement something like this in their class they are shot down by parents and by a lack of knowledge in the community” (Teacher 19, Site 3). She felt that more knowledge and understanding about pedagogy and space in the school community would better empower parents to permit teachers to engage with more diverse pedagogies.

Fostering a community of practice

Teachers felt that engaging with new practices involved an element of risk and that a collegial approach to change could help support them to try new ways of working. Conversations between teachers were important to enable them to reflect upon and discuss their experiences within new spaces. By sharing these experiences and evolving individual understandings of space, collective understandings of pedagogy and space were also advanced. However, it was recognised that a sense of trust was needed amongst teachers to encourage openness and transparency with respect to sharing experiences of new practices. A teacher noted “people will not take risks if they feel they are being judged by something that didn’t work” (Teacher 8, Site 2).

Fostering communities of practice (Lave & Wenger, 1991; Wenger-Trayner & Wenger-Trayner, 2015) around the use of new learning spaces was seen to be a valuable strategy to create conditions for teachers to share stories about their experiences of trialling new practices. Collaborative reflection enabled teachers to articulate, analyse and share their experiences, helping individuals to better perceive, utilise and shape the affordances of their learning spaces. In turn, this enhanced the sense of team and trust which was important to fostering a culture of change.

Regular discussion amongst teaching teams around issues such as school values and direction, student learning and use of the physical environment was helpful for teachers to connect with and learn from others. These discussions often took place within organised action-research groups and were pivotal to helping teachers extend their own perceptions about what learning should and could look like. In discussing collegial conversations, a teacher noted that a feeling of connection provided staff with the "impetus to move to something different" (Teacher 4, Site 1).

These findings resonate with Wallace's (1999) study on teacher collaboration, which found that trust was critical to the development of collaborative cultures and that this depended on personal relationships formed amongst team members. Similar to this study, it was identified that qualities of mutual trust and respect were best developed through regular conversations amongst smaller groups (based on learning teams or departments) rather than across whole staff cohorts. These findings also resonate with those of French et al. (2019), who identified 'culture' as one of four key strategies for successful transition to ILEs. French found similar themes relating to high levels of teacher autonomy, strong relationships between educators and administrators, and allocating time for teachers to share their experiences about adapting practice, all contributed to cultivating a culture of reflection, risk-taking and change.

The importance of 'culture' as a strategy to support practice change within the context of actualising ILE affordances points to broader issues that need to be contended with around enabling ILE spaces. Lindberg and Lyytinen's (2013) affordance ecology framework which recognises the intersecting spheres of organisation, practice and infrastructure recognises the need to align multiple aspects for actualisation to take place. This framework offers a useful structure by which to consider strategies to enable learning environment affordances.

Purpose

Unless people understand a need to change, there may be reluctance to engage with it. As McGuire (2003, p. 5) notes, "if I am not convinced at a deep level about why change is necessary, then I will not develop the willingness essential to supporting a new direction". Similarly, Sinek (2009) suggests that a need to understand the rationale for change is central to success, particularly with respect to innovative initiatives.

Hence, for teachers to successfully use the affordances of ILEs they require clarity about the purpose of these new space typologies. Teachers described having different levels of cultural comfort, and therefore appetite, for the practice change required to utilise the affordances of ILEs. It was felt that there was a status quo of teacher-directed instruction and that varying from this required considerable effort.

In describing the need to better understand the benefits of ILEs in order to be motivated to change practices, a teacher noted, "I think people that find change really uncomfortable have to really believe in the benefit of the change. If they can't see the point in it, they can't see why they would" (Teacher 2, Site 1). Having a clear purpose for the use of space also better enables clarity around how space might be used. As noted by a secondary teacher:

> If you have a clear purpose for what you're using the space for and you're organised in how you want it to look and what you want the outcome to be for using that space, it makes it easier. (Teacher 6, Site 2)

Three enabling factors were found to support teachers to develop a greater sense of purpose around the benefits of ILE spaces. These were 1) professional learning, 2) visiting other innovative organisations and spaces, and 3) being able to access research and evidence around how space can support better pedagogical practices. These are discussed below.

Professional learning

Some participants noted that they had little exposure to conversations around the relationship between pedagogy and space in their teacher training. They felt that professional learning opportunities bridging these themes had been helpful to raise their awareness of space as a resource for teaching and learning. One teacher felt that amongst teachers there was a sense that the curriculum constrained and determined their approaches and this could be considered a barrier to change. She described a professional learning program she attended in which National Curriculum core competencies around 21st century skills were aligned with

pedagogy and space, and this had helped her clarify her own understanding of teaching and learning, including how innovative learning spaces could play a role in supporting her practice.

Co-teaching was another area that did not appear to be well-covered in teacher training. A participant noted that he didn't "get any look into co-teaching or these flexible learning environments" (Teacher 9, Site 3) at university. He felt that professional development focussed on team-teaching in ILEs would be particularly helpful for teachers to enable them to appreciate the affordances of ILEs. As ILEs are commonly designed with the intent of enabling more diverse pedagogies, including team teaching, unless teachers are trained to co-teach they may not recognise affordances that support co-teaching approaches.

These experiences align with Leighton and Byer's (2020) perspective that although teachers are taught curriculum content and pedagogy, they are rarely trained to consider how space can support learning. As the primary lens of educators is pedagogy rather than space, viewing space through the lens of pedagogy can help illuminate how ILEs may enhance teaching and learning practices. Furthermore, Mackey et al. (2018) note that when transitioning to more student-centred approaches to teaching and learning "it is critical teachers have professional learning and development opportunities to use purpose built facilities to their full potential" (p. 468). Cleveland (2011) also noted that formal professional development was needed to enable successful transition into ILEs.

Research and evidence

Research on ILEs was recognised as a useful resource to help teachers gain understandings of the relationships between pedagogy and space. Participants felt that it was valuable when schools empowered teachers with evidence around how ILEs supported deeper student learning. Having access to research findings helped develop teacher's knowledge about the benefits of ILE spaces, giving more impetus for teachers to engage with the challenges and opportunities of using them.

Two sites from Study 1 had implemented research sharing initiatives to inform teachers about the benefits of ILE spaces. Site 3 provided incoming teachers with induction packs containing information related to the school's philosophical position on learning spaces, including references to current research on ILEs. At Site 4, teachers engaged with regular professional learning programs addressing issues aligned with culture, practice and space.

Field trips

As teacher's professional contexts are mainly spent embedded within the organisational structures, spaces and practices of their schools, it can be difficult for them to imagine a different reality. It was reported that professional learning that involved taking teachers to see how other innovative organisations operated had been valuable to help them see beyond what they already knew.

As well as visiting innovative schools, it had also been useful for teachers to visit contemporary workplaces. Seeing the types of environments that students could graduate to had been eye-opening for teachers and highlighted how they might need to think about how to prepare their students for future careers. As well as seeing other spaces, hearing directly from users about how their spaces worked in practice was valuable in providing a complete picture of how space supported practice in different contexts. Through these visits, by seeing the affordances of contemporary workplaces, teachers were able to open their minds to how these ideas might translate back to a school environment.

Recognising that teachers rarely address space as part of their training (Leighton & Byers, 2020) brings to the fore the importance of professional development for schools that are introducing, or already have, ILEs. For many teachers, their practices have been shaped and patterned through their own schooling, training and professional experiences. As Atkin (1996) notes, "many practices in education are the legacy of a previous time, of a mindset appropriate for a different era". These perspectives may need to be re-shaped to help teachers understand the purpose of engaging with the practice change required to successfully use ILEs and pursue pedagogies for deep learning.

Perception

As Gibson (1979) notes, affordances may remain latent in the environment unless they are perceived. Hence, perception is required by school users for affordances to be 'picked up' and used. Enhancing teacher's perceptions of the affordances of learning environments involves raising awareness of the pedagogical opportunities of spatial contexts. Whilst field trips were also reported to enhance perceptions of affordances, teachers spoke of a range of practical strategies in the classroom that had helped broaden their own perceptions beyond the status quo of what they had previously associated with teaching and learning.

Through these strategies, they were better able to appreciate how qualities of space were able to enable or constrain practices they wanted to foster.

Observation was one approach that enabled teachers to see other teacher's and student's activities within learning spaces, and through doing so, reflect on how space influenced the activities and interactions taking place. Prototyping was identified as a more active and hands-on approach, allowing teachers opportunities to enhance and embed new understandings of their practice within new spaces.

Observing students

A number of participants mentioned that earlier in their careers they believed that teaching should take the form of didactic instruction, positioning teachers at the front of the room. However, having opportunities to see students engaged in learning in alternative settings and spaces had challenged their earlier preconceptions. It was felt that in more student-centred pedagogical contexts that students were engaging with learning at a different and deeper level than they had encountered previously in more traditional environments. One teacher recalled her preconceptions being challenged when on an educational exchange to another school:

> For the first couple of weeks I was like "the kids are sitting on beanbags, that's not learning … sitting around the table chatting, that's not learning" and it was actually for me observing and giving them the opportunities to show me what they were doing. The conversations they would have … was a real eye opener. I was like, oh my gosh I didn't realise that school could even look like this. (Teacher 17, Site 5)

Participants felt that engaging students in learning required giving them the agency to take control of their own learning. This meant that rather than solely teaching from the front, that the focus needed to shift to embracing more pedagogical variety. A teacher noted that "the best learning might be really loud … it might be taking place over where the kids are hidden half behind the screen and on cushions … it's loud and it changes and moves" (Teacher 18, Site 5). Further, it was felt that more student-centred approaches require teachers to adapt from teacher-as-expert to facilitator of learning. For this to occur, teachers needed to learn to 'let go' and 'release control'.

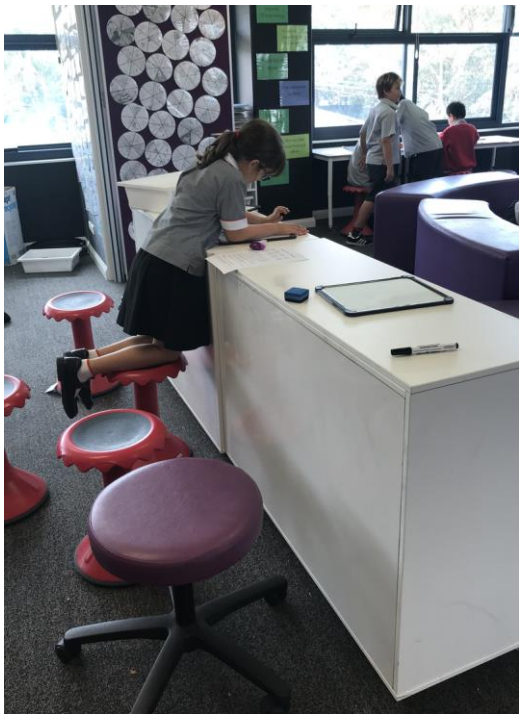
Saltmarsh et al. (2015, p. 325) noted that once teachers are able to see the benefits of more diverse pedagogies, they are often more open to moving away "from strictly defined, highly structured notions of teaching and learning", towards an understanding of pedagogy

offering more agency for both teaching and learning. They noted that more spatially responsive pedagogies enable "greater willingness for experimentation, professional risk taking, and co-learning between teachers and students" (p. 325).

Through these interviews, it was recognised that when students had more choice in how they worked, that affordances not perceived or used by adults had more opportunity to emerge. For example, at Site 3 teachers noted that students enjoyed standing to work using the tops of shelving units as writing surfaces (refer Figure 60). Teachers had not previously considered this to be an affordance until they saw students working in this way. This finding shows the individual nature of affordance perception and the need for further studies through which to explore student's perspectives of learning environment affordances—and alignments with teacher's expectations of what learning should look like.

Figure 60

Standing workspace: student using the top surface of a shelving unit as a workspace (Site 3)



Observing teachers

Given the predominance of traditional school typologies (Imms et al., 2017) that allocate teachers to individual classrooms, it can be uncommon for them to see each other's practice. However, opportunities to observe practice were found to help teachers reflect upon

their own practices and perceptions of spatial affordances. These opportunities could occur through organisational or spatial contexts.

At Site 3, the timetable was structured around a mentoring system where pairs of teachers and their classes were scheduled to be in the same physical space (a paired classroom with shared breakout space) at the same time. This meant that they needed to plan lessons and teach together. This was particularly beneficial for less experienced teachers who had no prior experience of co-teaching. Through these partnerships, newer teachers evolved their teaching practices through opportunities of practicing with more experienced teacher's. As teachers gained more understandings and experience of the co-teaching context, and each other's abilities, they were able to broaden their pedagogical repertoire.

More open spatial configurations were also found to raise teacher's awareness of other ways of practicing. This was identified at Site 4 where teacher work zones shared by four teachers were co-located with open, large learning spaces (refer Figure 26, Chapter 3). As the learning spaces at this school were all rather open, teachers were able to see other practices taking place as they moved through the building. The location of the workspaces meant that teachers were regularly able to observe other classes in close proximity. This allowed teachers to pick up on multiple ways to use the same space for teaching and learning through observation of other's practice. One teacher noted that on any given day she could see four classes run in four different ways by four different teachers. She noted:

> You look at the teachers, you look particularly at the students and how they're responding to that pedagogy being enacted and you can see is that working? ... Do I want to try that out? Would that work for this lesson that I've been planning? And sometimes it's almost unconscious. Like it's there so often and you're just processing that information and it'll just bubble up and you're like "oh, this would be a really good idea" when you've never implemented that before. (Teacher 15, Site 4)

The design of the spaces described in both scenarios facilitated teachers' abilities to shape their own practice and use of space through having opportunities to observe other teachers in practice. This enabled deeper and more nuanced insights into the affordances of learning spaces. Co-locating teacher work areas with learning spaces enables teachers to informally see how other teachers and students interacted within spaces, allowing them to reflect and embed these insights into their own pedagogical repertoire. As Bradbeer (2016) points out, spaces that enable co-location offer "the ability for teachers to collaboratively plan, work together and share professional development" (p. 80). The ability to work together may

enable teachers to get support and encouragement from each other, fostering more team approaches towards developing pedagogical alternatives (Bradbeer, 2016; Wallace, 1999).

Prototyping

Prototyping is a methodology which allows teachers to trial and test new practices in advance of the opening of new ILE spaces. It involves creating or adapting physical structures to support hands-on and practical ways to experience new ways of working. Through the action of engaging with prototype spaces, teachers may learn to recognise affordances which may not exist in traditional learning spaces.

In this study, participants felt that the presence of flexible spaces was critical to enabling opportunities to experience more diverse pedagogical practices. A teacher noted "when you're in a space that's flexible you're more inclined to try new things—you see more possibilities in what the space can offer" (Teacher 15, Site 4).

Examples of spatial prototypes described by participants ranged from furniture rearrangements to simple low-cost building adaptations. A teacher at the museum learning space (Site 5) noted that back at her previous school they had removed doors between adjacent classrooms to allow teachers and students to move more fluidly between the two spaces, enabling more collaborative teaching practices. At the same school, teachers had also been encouraged to reconfigure existing furniture into more collaborative learning settings to better support student collaboration. These initiatives had been found to help teachers trial practices during the construction phase of a new ILE building.

Teachers from the traditional school sites found that appropriating spaces beyond their cellular classrooms widened the array of physical settings available for student learning. At Site 1, an outdoor deck adjacent to three classrooms meant that three class groups could use this space to support more collaborative approaches to teaching and learning. This enabled teachers at this school to prepare for more collaborative teaching practices in advance of the delivery of a new ILE building.

The effective use of prototype spaces was enhanced by adapting organisational structures. To activate their prototype space, one school had adjusted the timetable to allow teachers to plan and prepare lessons in order to teach together. This school felt that due to the difficulty of shifting practice, it was best to only engage teachers incrementally with new practices. Therefore, team teaching was scheduled for mornings only so that teachers could revert back to individual class teaching in the afternoons. Time to allow teachers to reflect

upon the new practices they were trialling was also allocated into the schedule. Teacher 20 noted:

> Taking it in little steps is probably the best way of going about it … It's really hard for some teachers to make that adjustment and I honestly think that some teachers can't do it. But definitely the little steps and lots of discussion about if something didn't work why didn't it work and how can we change it and make it so it does work. (Teacher 20, Site 5)

Similar to findings from this study, Osborne found that the benefits of prototyping included growing teacher capacity, decreasing anxiety around being observed by other teachers, facilitating conversations amongst teachers about their practice, and being able to control a limited set of variables allowing users to focus on particular areas at particular times. As Lackney (2008) notes:

> [the] knowledge that teachers have about the role of the physical setting on teaching and learning was likely gained from direct experience and trial and error experimentation, rather than formal education and training (p. 136).

If this is the case, and we want the affordances of ILEs to be optimised from the outset of the delivery of a new building, then it is important teachers are given opportunities to practically experiment and develop their spatial literacy during building development. Developing prototype spaces to support the development of teacher spatial competency (Leighton & Byers, 2020), in tandem with the design and construction of new ILEs, was found to support this process.

Protocols

A big challenge for teachers moving from traditional learning spaces to new ILEs is shifting from sole ownership of the classroom to shared ownership of larger learning spaces. De-privatised practice within de-privatised spaces requires teachers to work together to share resources and spaces for teaching and learning. Bradbeer (2016) notes that it should not be assumed that "on occupying new collaborative spaces teachers will know what to do" (p. 85). Unless there are shared understandings about the expectations of more collective practices within shared spaces, divergent views on how they should be inhabited may cause conflict.

Expectations

A number of teachers talked about the need for protocols to be in place to ensure common understandings about how spaces should be inhabited. Protocols gave users guidance about the expectations of how people could interact with the affordances of space and with each other. Rather than being restrictive, the protocols discussed sought to empower users to have more agency around the use of space.

At the museum learning space (Site 5) there was a range of diverse furniture settings and technologies that could be used to support learning activities. At the start of each session museum educators (from Site 5) were explicit with students about their space use protocols. The intent was to give students autonomy to manipulate furniture and technology, and for them to feel like it was 'their' space. It was felt that by doing so, students had a greater sense of ownership and empowerment to engage with the affordances offered by the learning space.

The need for students to be given permission to have autonomy in their learning is not unlike the need for teachers to be empowered to try different approaches. Explicitly encouraging students to take ownership of the space gave them the opportunity to work in more student-centred ways. Examples like this, align with French et al.'s (2019) concept of 'enabling constraints' where physical and organisational constraints actively discourage traditional pedagogies.

Lexicon

At the Site 3 primary school, it was found that using an affordance lexicon was a valuable way to support users in recognising the potential of space for teaching and learning. The school had developed terminology about the types of activities and behaviours that were best undertaken in different types of spaces. This drew upon Thornburg's (2001) structured archetypes used in relation to technology spaces: campfires, caves and watering holes. 'Campfires' referred to tiered spaces which accommodated explicit large group teaching (see Figure 61), 'Watering holes' referred to circular tables for collaborative activities (see Figure 62), and 'Caves' were individual tables facing into the wall to support more quiet and reflective individual tasks (see Figure 63).

Figure 61

'Campfire' gathering space (Site 3)

Figure 62

'Watering hole' collaborative workspace (Site 3)

Figure 63

‘ Cave’ independent workspaces (Site 3)

Having a shared functional language (Heft, 1988) provided terminology to help students articulate their learning needs. The simplicity of the language meant that even children as young as Kindergarten level were able to engage with the concepts and understand the expectations of working in spaces with multiple options for learning. Engaging with the learning space using this lexicon was also found to help develop teachers and students sense of spatial literacy (Fisher, 2004). Describing the protocols within a Kindergarten context, a Site 3 teacher noted:

> Establishing what those learning spaces are and what their purpose is for is really important, and then continuing to develop that language by just using it all the time and they will start using it all the time ... Now you hear them say “well I feel like a watering hole would be really good for this activity” and you’d say, “why do you think that?” [and their response might be] “because I don't really know a lot about this topic, so I’d really like the opportunity to go and share my ideas with a friend. (Teacher 12, Site 3)

This language was used not only by teachers and students but also by the wider school community. It was found that having a common language reinforced the school’s values around pedagogy and space, enabling concepts and practices around ILEs to be socialised more broadly. In this way, parents had been able to learn about and engage with the school’s philosophy around pedagogy and space. The presence of the school’s lexicon helped teachers and students recognise affordances offered by their learning spaces. As well, it enabled the alignment of multiple perspectives around the expectations of how the varied settings within

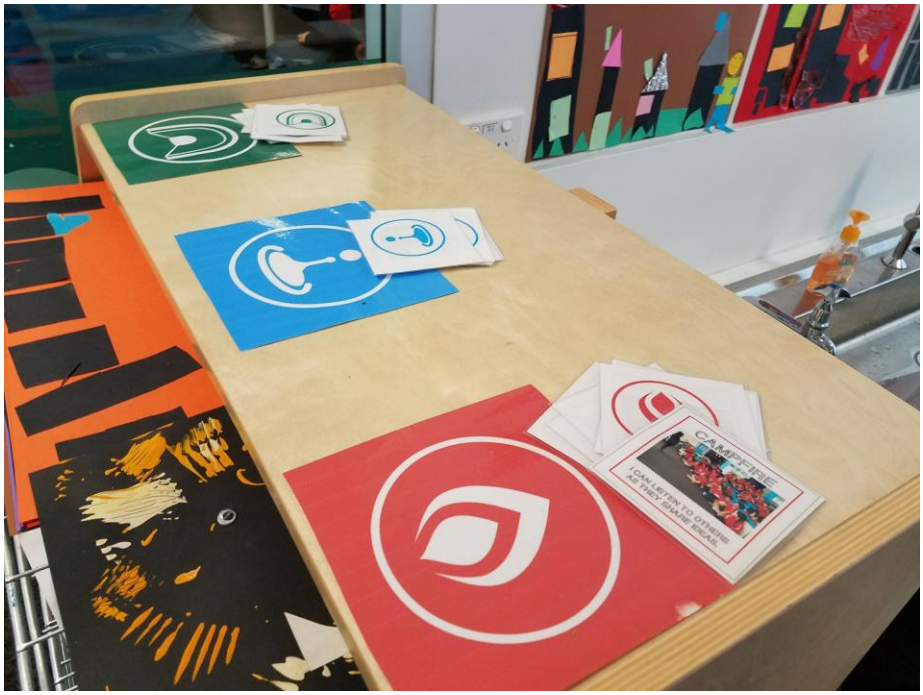
the ILE space could be actualised and engaged with. Rather than being form-based, the functionally-oriented language (Heft, 1988) used at this school was found to support users with specificity around the intent and potential uses of the space.

The lexicon used at Site 3 allowed students to be more intentional about how and where they worked. As part of the lexicon, visual cue cards (refer Figure 64) allowed students to signify their selected pedagogical mode when they chose to work in a space generally designated for other purposes. For example, whilst the large racetrack shaped tables were generally understood to be used for more collaborative purposes, if a student wanted to use this space for more independent work, placing a 'Cave' card on the table signified to others that the student working there did not want to be disturbed.

The lexicon cards aided students to think about space as a critical part of their learning, helping to develop their spatial literacy. These visual cues clearly and effectively articulated learning environment affordances in a simple way, as "valuable tools to communicate about expectations and activities without excessive repetition" (Saltmarsh et al., 2015, p. 321).

Figure 64

Lexicon cards for Campfire, Cave and Watering hole (Site 3)



Note: Image courtesy of Raechel French.

Conclusion

This chapter highlighted that teacher's perceptions of practice and space may be shaped by their own traditional schooling experiences (Atkin, 1996; Saltmarsh et al., 2015). With little training at university on the use of space to support their practice, teachers may have limited spatial literacy to aid them in actualising the affordances of non-traditional learning spaces.

To be able to use affordances, teachers first need to perceive them. This chapter identified a range of enablers for the awakening of consciousness of teachers (Crotty, 1998) to opportunities for learning offered by ILEs. It identified four key themes—culture, purpose, perception and protocols—which can support teachers to see the potentials of ILEs, recognise their affordances and actualise these spaces to their pedagogical advantage.

The findings in this chapter highlighted that a range of often interrelated factors can support teachers to actualise new learning environment affordances. As new learning spaces often require new practices, strategies for actualising affordances have association with features of change initiatives such as aligning to organisational values, participatory staff involvement, and incremental changes over time (Osborne, 2018). Many of the factors found overlap with French et al.'s (2019) themes of success strategies in the transition from traditional spaces to ILEs and the spatially responsive pedagogies discussed by Saltmarsh et al. (2015). These include factors such as strong leadership and the existence of communities of practice to encourage a culture of risk-taking, professional learning to enhance teachers sense of purpose to engage with change, enhancing perceptions and embedding new practices through observation and prototyping, and enabling shared understandings through protocols.

The contexts and initiatives that have supported teachers to use new learning spaces discussed in this chapter provide a starting point from which to further explore potential strategies and tools to help teachers to perceive, utilise and shape the affordances of new ILE spaces.

Study 2, discussed in Chapter 6, draws together and advances some of the themes that emerged from Study 1. It investigated ways to support and reinforce the rich and deep team discussions about the process of trialling strategies to support teachers' practice change. Initiatives such as prototyping space and practice, observing others practice, and protocols for change are discussed as part of the exploration of potential strategies to support teachers transition from traditional classrooms to ILEs.

Chapter 6. Actualising the Affordances of ILEs: Enabling Teachers

Introduction

This chapter discusses strategies intended to support teachers to take advantage of ILEs in support of deep learning pedagogies. It addresses the process of practice change required for teachers to actualise new affordances within ILE spaces and responds to the question, *How can teachers be supported to actualise the affordances of ILEs for deep learning?*

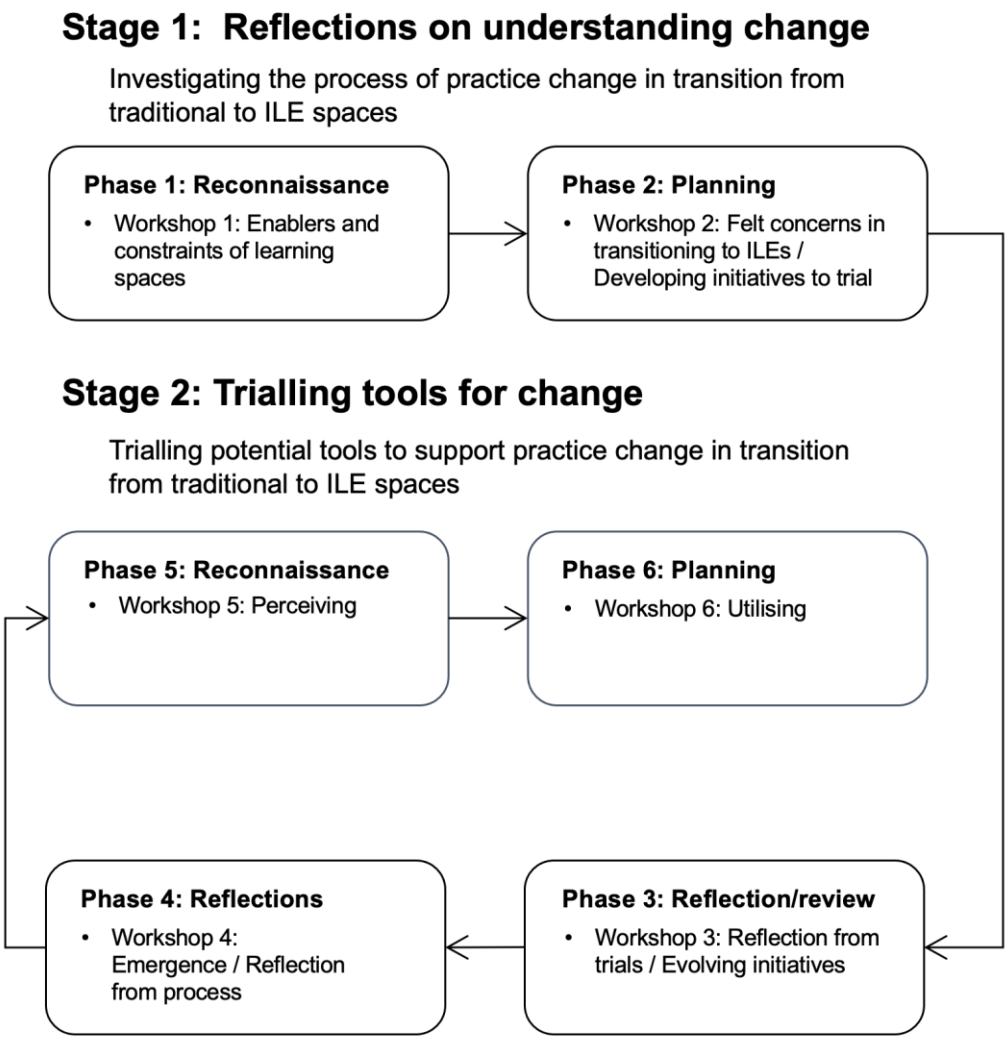
The findings presented are from Study 2, in which the development of 'strategies' and 'tools' to support teachers to actualise the affordances of ILEs for deep learning were explored. As noted in Chapter 3, a 'strategy' was considered to be an explicit concept, theory or a practice determined from case studies which enhances teachers use of ILEs, whereas a 'tool' was identified as an identifiable activity or protocol that implements the strategies (Mahat, Bradbeer, Cattlin, et al., 2018).

The findings reported here arose from a collaborative participatory action research (PAR) (Kemmis & McTaggart, 2005; Kemmis et al., 2014) and co-design (Melo, 2018) process, with teachers from two schools, that was designed and facilitated by myself and Dion Tuckwell, a fellow PhD candidate in the ILETC project. The study was iterative in nature. Initial findings were synthesised toward informing the development of tools which could be used by teachers at varying stages of the transition process to help them actualise ILE affordances. As part of their development, these tools were tested with teachers through the study.

As outlined in Chapter 3, Study 2 was conducted as two distinct stages. Stage 1 investigated the processes that teachers went through to shape their perceptions of learning environment affordances as they embarked on the transition from traditional classrooms to ILEs. Stage 2 was used to trial potential tools to support teacher transition. These were developed based on findings that emerged from Study 1 (see Chapter 5). Figure 65 shows the different stages and phases of Study 2, indicating the workshop focus of each phase.

Figure 65

Study 2 process



The findings from Study 2 reveal a range of issues teachers found challenging about transitioning to ILE spaces. Concerns included knowing how to team teach, being able to release control to enable more student-centred practices, tracking student learning with more students in larger spaces and the propensity to fall back to teacher-centric modes of instruction.

In addressing some of the concerns through the PAR/co-design process, a series of strategies that supported teachers to perceive and utilise the affordances of ILEs were identified. Some of these strategies were also identified in Study 1 (see Chapter 5). These included belonging to a community of practice, observation of teacher practice, and the need for protocols to enable teachers to work together in shared spaces.

The constraint of time was also a reoccurring theme across the two stages of this study. Teachers who worked independently in traditional classrooms generally had the autonomy to develop their own lessons. However, the need to plan to work together in shared spaces was considered challenging within school timetabling structures. Secondary teachers were often scheduled to teach multiple class groups across the course of a day or week, with limited concurrent 'free time' to meet with other teachers. Timetables were also rarely configured to enable teachers to teach together.

The learning environment affordances identified in Study 1 were introduced to participants at the beginning of Study 2, seeding conversations about space and practice. This enabled in-depth insights to be shared regarding many of the affordances identified in the taxonomies developed in Study 1 (as discussed in Chapter 4).

Below, I report my findings and discuss these in relation to the literature in two sections:

- Reflections on understanding change (Stage 1) and
- Trialling strategies for change (Stage 2).

In the first section, further insights into affordances are discussed in relation to teachers' perceptions about space and practice. Teachers concerns about transitioning to ILEs and strategies for change are also addressed. In the second section, findings from the trialling of tools are also discussed. Outcomes from this study reinforce – and bring further depth of understanding to – the initial investigations into learning environment affordances from Study 1.

Stage 1: Reflections on understanding change

Aligning space with practice

In the initial phase of Stage 1 (Workshop 1), participants were asked to consider how selected spatial qualities (found in Study 1 to support deep learning approaches – see Table 15, Chapter 3) enabled or constrained a series of learning principles. This was captured graphically by participants (Figure 37, Chapter 3) and responses were tabulated (refer Appendix H). The learning principles associated with the highest number of spatial qualities were found to relate to collaborative learning, intrinsic motivation and accommodating diverse learners. These themes align with the aspirations of deep learning, reinforcing the relationship between these spatial qualities and deep learning pedagogies.

Enabling qualities. The action possibilities that teacher participants felt positively related to selected spatial qualities are outlined in Table 17. Many of the qualities listed had multiple affordances, with more than one action possibility identified. This extended understandings of the learning environment affordances identified in Study 1. Many of the qualities deemed important by participants in Study 2 had also been highly rated in the earlier study. Enabling spatial qualities included having a range of different settings, space that can be changed/used in different ways, moveable furniture, and virtual workspaces/digital resources. Vertical whiteboard surfaces were found to be the most highly rated spatial feature. Teachers indicated that this quality positively empowered students in their learning.

Table 17

Enabling affordances for learning

Spatial quality	**Action possibility**

Writeable whiteboard wall surfaces	• Enables thinking to become visible through:
	  ○ Instant feedback from peers and teachers
	  ○ Aiding discussions
	• Sharing ideas and ways to learn

Space that can be changed/used in different ways	• Explicit teaching to the whole class or smaller groups • Lots of different grouping options • Flexibility to sit, stand, work in a comfortable manner • Student choice in learning settings • Encourages new pedagogical approaches
Smaller defined areas	• 1:1 or small group quiet work • Enables a safe space for intervention
A range of different settings	• Instant feedback (one-on-one, or in smaller groups) • Ability to spread out, think and reflect • Students to work on an area of particular need at their own pace • Enables different learning styles
Moveable seating and work surfaces	• Flexibility to change settings

Space for teachers to work together	• Enables teacher collaboration:
	  ○ Sharing effective teaching strategies
	  ○ Grouping collaboration feedback
	• Reflection on own practice through dialogue

Virtual workspace	• Enables feedback to be given without face-to-face contact

	• Potential to represent non-verbal thinking
Digital resources	• Multiple ways of instructing • Off-site learning toward greater personalisation
Other students	• Peer feedback • Ability to assist, encourage, compare with others to inform understanding
Display spaces	• Ability to reinforce standards, instructions, goals, expectations etc. • Ability to revisit knowledge when being tested • Representation of student work • Enables feedback from students and teachers • Enables display of keywords and ideas
Larger than traditional learning spaces	• Movement, flow and multiple learning opportunities
Connected spaces	• Ability to group students to work in different areas
Acoustic absorption and other devices to support sound quality	• Allows for clear communication • Enables discussion to work effectively in a large group

Whiteboard surfaces. Whiteboards surfaces were found to enable students to "share their ideas" and "teach others". Similar to the whiteboard tables discussed in Chapter 4, the impermanence of the whiteboard surface was noted as giving students greater confidence to explore ideas, creating a different dynamic than when writing on permanent surfaces. A teacher noted:

> What they love about it is they're not afraid to make mistakes and to make changes because they can easily erase them and they realise that … their ideas are fluid, they're ever changing ... When they're writing in a book, they get all nervous about it 'cause they don't want to make mistakes and so they often stop themselves from making a point. (Workshop 6 participant[12], School B)

Teachers found that spaces which had multiple whiteboard surfaces encouraged students to actively engage in class. A teacher noted how students behaved in the School B prototype ILE space which contained multiple whiteboard surfaces (refer Figure 66) compared with a traditional classroom. She said:

[12] The nature of workshops, in which multiple people were in conversation together, meant that it was often not possible to identify the different participants voices on the audio recording. Quotes captured from workshops are therefore cited by workshop number and school.

> They'll get the whiteboard markers and they'll want to be writing on the walls … and that happens less so in my normal classroom. They don't ever think the whiteboard is their domain. Occasionally, they'll want to rub things off, but they'll never want to write. They find it daunting to come up and write there, but not in this space … maybe its breaking down that barrier between teacher space and student space (Teacher 33, School B).

Figure 66

Students engaging with whiteboard walls at School B

A whiteboard (or formerly a blackboard) at the front of the room has traditionally been the domain of the teacher. Having multiple whiteboards was said to diminish the sense of 'a front of the class' and open opportunities for more varied uses, including by students. Participants felt that in allowing students to use the whiteboards, they were effectively releasing control of the environment. A participant noted that by allowing students to use the whiteboards "you're entrusting them with some kind of responsibility, and you're saying you are just as responsible as the teachers, you're on the same kind of playing field as them" (Workshop 6 participant, School B). Another participant used the analogy of a relay baton to convey how access to the whiteboard could empower students in their learning. She noted:

> When kids are in a relay and they've got a baton and the minute that person gets the baton they then start running and that's their time and their show. I see the same thing happening. It's like when they get that opportunity to lead the learning, they run with it … even that little symbol is empowering to them. (Workshop 6 participant, School B)

These insights extend the original perceptions of the affordances of whiteboard surfaces beyond merely being a vehicle to display information, but one which can enhance opportunities for students to 'step up' and further engage in learning.

Constraining qualities. Table 18 shows spatial qualities perceived as constraints for learning. In Study 1, interactions with other students were considered an important aspect of deep learning. In Study 2, this was also noted by many teachers to offer the ability to assist, encourage, and compare to inform the development of new understandings. However, interactions within more connected spaces and the influence of other students were also associated with noise and distraction issues. Having open spaces where students were more frequently able to compare themselves with others was also felt to contribute to anxiety and lack of confidence.

Indeed, many environmental qualities were perceived as both enablers and constraints. This included virtual workspaces which were seen to offer opportunities for students to represent non-verbal thinking and get feedback without face-to-face contact. However, it was also recognised that when working virtually, some students did not collaborate well, or the development of social skills such as negotiation was compromised.

Table 18

Constraining qualities inhibiting learning

Spatial quality	**Constraint**
Other students	• Students don't always know how to collaborate – can detract from learning • Can cause anxiety, lack of confidence • Can cause comparison/barriers • May limit time for self-reflection • Noise, distraction
Virtual workspace	• Students may not contribute equally • Reduces social skills e.g. negotiation, compromise
Seating and horizontal work surfaces	• For some students the traditional seating style enhances stress
Moveable seating and work surfaces	• Can provide instability
Connected spaces	• Can be loud or generate sensory overload • Distracting

	• Cause more stress when comparing with other students work
Space that can be changed/used in different ways	• Students may take too long to settle with a changing space
Material and colour finishes	• Some finishes hinder a sense of shared discussion / thinking

Moveable spaces and furniture that could be changed or used in different ways rated highly, as it was thought to enable a range of learning approaches including collaborative activities and greater student choice. However, it was also felt that for some students this could cause a sense of instability, hindering them from settling into spaces that were constantly changing.

In addressing these contrasting perspectives, it was felt that a better understanding of collaboration was needed to use ILEs well. One teacher noted:

> Collaboration is a word we throw around a lot and I think there's an assumption we know what good collaboration is all about. But I don't really think many staff know what collaboration actually looks like that's effective because they often associate collaboration with … kids kind of getting off task. (Teacher 35, School B)

Discussions revealed that teachers needed to explore the concept of collaboration further in order to better understand how ILE affordances should be considered in supporting collaborative approaches to learning.

Traditional classrooms. Traditional classroom configurations were considered to constrain student's engagement and induce passive approaches to learning. It was felt that when chairs are lined up facing the front, it signified that a teacher "would take control of the lesson" and students perceived that "learning is going to be done to [them]" (Teacher 22, School A). Comparing a traditional classroom with the School B prototype ILE a teacher noted:

> In my other (traditional) class they're happy, well not happy, but they're compliant, they just sit there and absorb. They don't seem to want to take control…they're not on the edge of their seat and want to start work as much. (Teacher 33, School B)

The particular constraints of secondary schools, where teachers more frequently use multiple spaces with different classes, quickly became evident through the discussions. A teacher who was timetabled to 10 different class groups, all in different spaces, felt unable to teach in more diverse ways due to the pressures of timetabling. She noted:

> I'm not inclined to teach in rows of chairs and desks, but often I … go in and I can't change it because I'm there for one lesson every two weeks. It belongs to someone else and then I'm bound to sit the kids like that. (Teacher 24, School A)

The limited space within traditional classrooms was found to be more difficult for group work and teacher and student movement. Barriers of time, or protocols around changing settings, was said to prohibit more diverse pedagogies within traditional learning spaces.

Additional learning environment affordances. Rather than having a direct action possibility associated with learning activities, materials and colour finishes were perceived in Study 1 to only have an affective influence on school users (refer Chapter 4). As a result, these qualities were not included in the earlier taxonomies of learning environment affordances. However, insights from Study 2 revealed opportunities for these qualities to offer action possibilities and therefore be considered as affordances for learning.

For example, rather than just influencing how people might feel, the use of colour was perceived as a useful device to support the organisation of student groupings. Colour used on walls could symbolise a particular behaviour or activity e.g. an area of blue wall could help demarcate a zone designated for a particular behaviour.

Similar to the beneficial use of environmental graphics or affordance cue cards identified in Study 1, these visual cues allowed users to easily communicate intentions around their learning activities in relation to space.

Materials and finishes used on walls were also felt to be able to hinder opportunities for shared thinking and discussion. It was noted that if surfaces were not 'pin-able' or 'writeable' they did not afford opportunities to display learning cues, information and ideas emerging from lessons. With these further insights from Study 2, colour and material finishes could be understood as an affordance for learning and should be considered in further development of learning environment affordance taxonomies.

Opportunities of ILEs. Teachers from both schools felt that their future ILE spaces would offer better opportunities for more differentiated teaching and learning practices than their current classrooms. For some, having the ability to co-teach was thought to more effectively address the needs of a diverse cohort of students. One teacher noted that it was currently challenging when working alone in a single cell classroom to address the needs of the range of abilities in her class. She said:

> Sometimes I feel like I can push myself and I support the kids who are struggling, but then that middle suffers. I guess I'm hoping with the flexible spaces and the two teachers, that we will be able to support all the kids more effectively all the time. (Teacher 21, School A)

It was felt that compared to traditional classrooms, ILEs offered "the privacy of a bigger space" (Teacher 22, School A), giving more opportunities to enact more diverse pedagogies with students of different abilities. Teachers also felt that teacher-directed pedagogies were not adequately preparing students with the agency required beyond school and hoped that by giving students more responsibility for their learning it would help them develop greater independence. A teacher noted:

> They go to uni and suddenly the total experience is their own and they don't have someone checking in as much or … providing resources over and over again. There's a greater sort of agency required once they leave school. And I think in those spaces too, if I'm able to develop the responsibility that you move appropriately, that you come and find me when you need me, I think it's gonna go to that greater development of learner. (Teacher 24, School A)

The use of new ILEs may also allow more mutual engagement within the classroom, requiring a redistribution of control than what traditionally might be experienced in traditional classrooms (Cleveland, 2016). Teachers envisaged students having more ability to share their work on screens and whiteboards and to change spaces to suit learning needs. It was felt that more engagement would increase the likelihood of student enjoyment of learning and enhance the ability for students to articulate their learning needs. Through doing so, a teacher noted, "I hope the spaces provide us with the chance to put the kids in the driving seat of the vehicle of their learning" (Teacher 22, School A). The opportunities for pedagogical change offered by new spaces were felt to help shape students more holistically as learners and develop their curiosity and passions. These aspirations for greater autonomy, engagement, and sense of purpose align with the deep learning 'climates' defined by Fullan et al. (2018) and Fullan and Langworthy (2014).

The ‘enabler and constraints activity’ undertaken as part of Workshop 1 provided stimulus for participants to think about and discuss how spatial qualities might influence learning activities and behaviours. Data emerging from this part of the PAR process offered valuable insights and a deeper reading of the learning environment affordances found in Study 1. Outcomes from this exercise suggest that the workshop activity could become a useful device to help people reflect on the relationships between space and action possibilities for teaching and learning, especially as a tool to help align architects’ and educators’ understandings of affordances in the design of learning spaces.

Planning & trialling new ways of working

In the second workshop, coded data from a first round of semi-structured interviews were shared with participants, who were invited to comment on whether the initial findings aligned with their own understandings. Themes related to observations of affordances, constraints of current learning spaces, and perceived opportunities and concerns about moving to new ILEs were discussed.

Felt concerns. Teachers’ perceived challenges associated with the move to new ILE spaces were relatively consistent across both schools. The challenges perceived related to:

- Managing large numbers of students in the same space at the same time.
- Noise associated with more students being in the same space together.
- Co-teaching with other teachers.
- Having time to prepare lessons with other teachers.
- Being observed by other teachers.
- Ensuring students were adequately assessed in their learning.
- Falling back to default practices i.e. teacher-directed practice.

Participants from each school agreed on a set of collective ‘felt concerns’ (Kemmis et al., 2014) around the imminent transition to new ILE spaces. These felt concerns became the basis from which participants designed and implemented a series of initiatives to explore these issues. Table 19 (below) shows the agreed concerns, and how these were rated by participants (with 1 being the highest possible rating and 4 the lowest). Not all concerns were shared between schools (as indicated by blank boxes in the table). The concerns that were consistent across both schools included, how teachers should engage with team teaching, how

to ensure that students didn't 'slip through the cracks' (get overlooked), and how shared elements such as display spaces should be used.

Concerns unique to School A tended to be focussed on how teachers worked together. They included the ability to find time to prepare lessons together and effectively collaborate. They also questioned a need to define the uses of different areas in their new ILE building. School B's highest rated concern related to exploring productive collaboration. They also had concerns about being observed by other teachers and becoming comfortable in giving students more freedom.

Table 19

Felt concerns

Felt concerns	School A	School B
What does productive collaboration look like?		1
How do we ensure students don't slip through the cracks when we are working together?	1	3
What does effective (teacher) collaboration look like?	2	
How do we learn to become comfortable in giving students more freedom, and releasing control?		2
How can we start to team teach in the space?	2	3
How do we avoid falling back to default?		3
When will we have time to plan lessons together?	3	
How do we get used to being observed (by other teachers)?		4
How do we use our display spaces in our shared learning spaces	4	4
Should we define the purpose of different types of spaces?	4	

Note: Felt concerns ranked in order of importance with 1=highest and 4=lowest.

At School A, it was recognised that teachers would be moving from one class of students in the same space to sharing spaces with another teacher and up to 60 students. At School B, there could be up to 5 classes (of 28 students per class) together on each floor of the new building (under construction). This raised concerns about how the likelihood of greater noise levels might impact teachers' ability to give students instruction in larger spaces.

With much larger classes, the potential to lose track of students was a common concern across schools. A School B teacher noted that this was already a problem in their prototype ILE space. She noted:

> When we're in a confined space I can very quickly see where they're at, where they're struggling, what they need me to help them with. Now I find having to move to a lot of different spaces, it slows me down, I'm not able to get to students as quickly. I think it's slowing down the learning actually as they're not getting feedback as quickly from me because I'm in different places. (Teacher 36, School B)

It was recognised by teachers that having more ways to track learning would alleviate their concerns about not being able to see all the students in the same space, and that this would potentially help overcome issues around trust aiding teachers to be able to release control and give students more agency in their learning.

A commonly reoccurring theme noted by teachers of both schools was the propensity to fall back to default teaching practices. However, it was only agreed as a felt concern by School B teachers, most likely because these teachers already had a prototype ILE space and were recognising the challenges of using it.

At School B, teachers' experiences of the prototype learning space varied considerably. Many were enthused about the presence of this space. As one teacher noted "it's making me think differently about my teaching" (Teacher 34, School B). However, other teachers recognised that they weren't using the new space differently from their traditional classrooms. One teacher noted that she really didn't know how best to utilize the space and that when using it she still did the activity she would have done in her classroom. She noted, "the shape was different, but the actual teaching wasn't" (Teacher 37, School B). This comment reinforces the findings of previous research (Halpin, 2007; Lackney, 2008), which suggest that new learning spaces can just as easily "act as containers for conventional as much as for more enlightened modes of teaching and learning" (Halpin, 2007, p. 251). Furthermore, it resonates with Bradbeer's (2016) suggestion that, "assumptions about the manner in which teachers approach teaching and learning, as well as their use of space, both individually and collectively, has the potential to lead to design incongruence" (p. 86). This recognises that teachers may have multiple perspectives on the use of space for teaching and learning, and that architects should involve a range of teachers in the design process to gain a comprehensive understanding of a school's context. By doing so, it enables teachers to hear from each other, broadening individual's understandings of space and others' views on it.

Enacting change initiatives. To explore the agreed felt concerns, participants from both schools discussed potential initiatives to be trialled before the next workshop. For example, many School B teachers (in recognising that collaborative learning could have association with students being disruptive or off-task) were interested in exploring 'group work' to gain a better understanding of 'productive collaboration'. Teachers discussed initiatives they would explore and how they would measure these, documenting their thoughts on a shared Google document (refer Figure 40, Chapter 3). Outcomes were largely measured through observations of how students used spaces, photographs taken of spaces in use, teacher's reflections, notes, and student surveys. Initiatives explored at the different schools are shown in Table 20.

Table 20

Felt concern initiatives explored in Study 2

Felt concerns	School A	School B
What does productive collaboration look like?		• Ability group students and differentiate tasks • Ability group students and give students different roles in each group • Group students based on topics • Randomly group students • Ability group students and get them to establish learning criteria
How do we ensure students don't slip through the cracks when we are working together?		• Students work in groups using shared Google doc projected onto screen in each space.
How do we learn to become comfortable in giving students more freedom, and releasing control?	• 'Hand over' the white board for students to use.	
What does effective (teacher)		

collaboration look like?	• Reorganising classroom with two other teachers to encourage movement and productivity.	• Team teach two classes in prototype ILE space & observe each other's practice
How can we start to team teach in the space?		
How do we get used to being observed (by other teachers)?		
Should we define the purpose of different types of spaces?	• Rearranging classroom into three distinct zones • Defining 'workstations' in room with specific teacher station and help lights • Put up poster on wall of room set up based on activity-based zones	

The range of approaches trialled across the two schools were influenced by the availability of time, school timetabling and classroom size. Although team teaching and teacher collaboration were high on the list of concerns for both schools, at School A it was difficult to implement co-teaching initiatives as the majority of trials could only take place within existing traditional classrooms. As school B teachers had a prototype ILE space to trial initiatives, they were able to test a greater range of strategies. However, as there was only four weeks between workshops and amidst already full schedules, a lack of time also hindered teachers in exploring team teaching.

Emergent themes for evolving practice

In Phase 3 (Workshop 3), participants reflected on the initiatives trialled through an activity which used the metaphor of 'outer space' to help them think through ideas of collective practice (as described Chapter 3). Subsequent to the workshop, they reviewed and adapted initiatives, and then re-trialled them before returning to reflect on these in Phase 4 (Workshop 4). A second semi-structured interview took place after this workshop. Key themes that were common to both groups of teachers are discussed below. The emergent themes related to:

- The importance of having discussions with other teachers across key learning areas.
- Having time to plan lessons together for team teaching.

- The need to have shared protocols around the use of ILEs which might include how to share spaces and how to track student learning whilst team teaching.
- Observing other teachers practice and getting feedback from other teachers on one's own practice.
- Drawing diagrams to think about potential space use as well as seeing other teachers thinking around the use of space.
- The value of hearing students' perceptions of how space influences their learning.
- Benefits of trialling and testing practice.

Community of practice. The most impactful aspect of the PAR/co-design experience for teachers was their engagement in discussions about the relationships between space and practice with each other. Regular discussions with teachers from other key learning areas helped shape individual understandings about pedagogy and space. One teacher noted:

> A product of what we were actually doing at the time didn't really matter, but it was the process of trying to think about what it would look like and spending some time with somebody else talking it through that really helped. (Teacher 26, School A)

Exposure to other contexts, particularly to teachers from other domains, helped them appreciate other ways of doing things. Through these discussions, participants gained insights into how other teachers approached teaching and learning within new spaces. It also helped them better understanding their colleagues' contexts. A School B teacher noted:

> Some of my boundaries are different to say M…'s boundaries … Things that she values and are important to her aren't necessarily mine. So, it's about contextualizing that use of space for different teachers and different personalities. (Teacher 37, School B)

Hearing other teachers' reflections helped develop empathy for their situations. Being part of a Community of Practice (Lave & Wenger, 1991; Wenger-Trayner & Wenger-Trayner, 2015) was found to support teachers in developing rapport and a sense of trust, and creating optimal conditions for collaboration, both outside and inside the classroom. These aspects also align with findings from other studies on teacher collaboration (Bradbeer, 2020; Wallace, 1999) as critical to supporting teachers in working together and evolving their practices. Regular discussion amongst a small group of teachers focussed on ILE spaces was found to help evolve and shape individual's perceptions of space and practice.

Time. Time pressure was a frequently reoccurring issue across both studies. A benefit for teachers in being part of Study 2 was having scheduled time to come together to focus on spatial practices. A teacher noted, "I know teachers always complain about time, but what the workshops allow is time to focus on a particular area rather than just letting things happen without consciously spending time on it" (Teacher 37, School B).

However, finding time to trial and test initiatives was challenging. One teacher spoke about the pressure of being part of this research project because she needed to find additional time from an already busy schedule to participate. She noted:

> Any effective change in teaching needs to be validated with time because we are time poor as teachers and there are a lot of things that want your time…to be an effective teacher you have to be able to give time to students. And so, we also need time to then actually change things. (Teacher 34, School B)

Despite the prospect of team teaching in ILEs as a felt concern, few teachers ended up trialling this due to logistical issues around timing. The few teachers who managed to focus on this issue found that they needed to use a lot of their non-school time to trial working together. Further time was required to come together to evaluate and reflect on what they had trialled. One of the teachers noted how important it was to make this time available to do justice to the experience. She said:

> The work I did collaborating with J… was probably the most helpful experience because we allowed ourselves … maybe an hour or two to really think about what we were doing and how we could best support our two classes. I really found that that time spent thinking about the purpose, the use of the space, that was really important … And then actually we spent a lot of time afterwards evaluating what worked and what didn't work, and that was also really, really helpful … Had we not had that thinking time ... I worry that we're just stepping into a space and using it but not as effectively as we might. (Teacher 36, School B)

School A teachers were also challenged by time and timetabling. Teachers could be scheduled into multiple rooms across a day, therefore needing time to set up and reset rooms, taking away from lesson time. In order to organise a space conducive to trialling a different furniture arrangement for a whole week a teacher at School A noted that she needed to arrange a room change where she had to ask several people to leave their rooms. At the end of the week she also lost time reinstating it back to the traditional row configuration.

These insights highlight some of the difficulties of a secondary school context in which teachers are often scheduled to teach a range of different class groups in multiple

spaces across a week. To support teachers in actualising the affordances of new learning spaces, it is critical for schools to enable scheduled time for teachers to meet, discuss and plan how they will collaborate within ILE spaces. Further to this, it is equally important for timetables to have the flexibility to allow teachers the ability to trial practices with others, and to be scheduled into spaces conducive to supporting these practices.

Cleveland's (2011) study found similar issues in relation to the need for time to assist teachers to engage with new pedagogical practices. In his study, time for team planning and critical reflection was identified as a major restriction to developing new teaching models and practices. He further found that timetables where students and teachers were only scheduled in new learning spaces for limited amount of times reduced opportunities for shared understandings of space usage to develop.

Protocols for change. The need for protocols was identified to assist collective understandings of expectations around new ILE spaces. Teachers at School A discussed the importance of default guidelines to define how spaces could be used. They felt that if both teachers and students better understood what spaces could be used for, it would enable more efficient and effective use. A teacher noted: "I think it's good to have spaces within classes that's well-defined, so you can just say today it's pairs and they would know where to go, and it saves time, it increases compliance" (Workshop 2 participant, School A).

In spaces shared by multiple people, it was felt that teachers would benefit from shared understanding about the expectations of how spaces should be left for others. It was also felt that protocols would support students' understandings, as it was recognised that if multiple teachers used the same spaces in different ways it may be confusing for students. Shared guidelines were proposed to alleviate this issue. In fact, it was felt that high levels of structure are required to enable more freedom and choice in ILEs. One teacher noted:

> Differentiation and explicit instruction…is something that needs to be much more kind of built in for the kids to be a little more autonomous… they kind of go against each other in some ways…but you've got to build the structure for them to know how to work together and then they can actually do it themselves. (Workshop 2 participant, School A)

In more self-directed learning contexts, this would provide students with structures to help them to understand how some types of spaces might be suited for some tasks over others. This was identified in Study 1 (see Chapter 5), where an affordance lexicon was developed and used at an ILE primary school (Site 3). Having a common lexicon and

protocols around spatial understanding may enable more efficient use of space (Lackney, 2008; Newton, 2009). However, participants agreed that rather than being prescriptive, baseline protocols should not dictate how teachers use learning spaces, but act as a guideline and prompt from which teachers can extend their practice and potential uses of ILEs to suit different learning contexts.

Observing practice. Despite initial concerns about being observed by others, teachers who trialled observation of practice found it a positive and constructive experience. Many teachers had never had other teachers come into their classes before, so the idea of teaching in front of others was somewhat daunting. A teacher noted "teachers are notorious for being in a classroom and no one sees what they do. It's only some teachers that cope well with others witnessing what they do" (Teacher 27, School A).

One of the teachers who trialled team teaching recognised that being observed raised consciousness of her own practice. She noted:

> J… observed one of my lessons in here and she said to me, "you know, some of the students have their back to you", and I said "yeah I know but … there's not enough seats and then if I get them to move I lose too much time', and then we kind of talked about that. It made me think a bit more divergently about how you kind of overcome things. (Teacher 34, School B)

Being the observer also helped expose teachers to pedagogical approaches which they may not have previously considered. The teacher observing the lesson above felt that she too learnt a lot watching her colleague teach and that more opportunities to observe practice would be beneficial in developing her own understandings of the pedagogic use of space. In addition, this teacher felt that it was valuable for students to see their teachers modelling collaborative behaviours and to realise that teachers are also learning. She noted:

> It's really good as well for the girls to see teachers sharing ... 'cause often girls don't see that … It's really good for them to see us collaborating and see that … teaching is a very dynamic process, it's always evolving just as the learning is. (Teacher 36, School B)

In fact, the Principal at School B consciously scheduled school executive meetings in the learning space known as the 'Boardroom' to enhance the experience of 'seeing' and 'being seen'. The Boardroom is highly visible as it is separated from other learning spaces by large areas of glazing. The initial intent of scheduling meetings there was to model staff

collaborative behaviours to students, however it was also found to be helpful for the leadership team to see activities taking place in the prototype space. The transparency enabled teachers to discreetly and often sub-consciously observe others practices within the prototype space. One teacher noted that she began to use the space to do her marking as it was useful to "secretly observe how other teachers use the spaces" (Teacher 34, School B).

In traditional teacher-owned classrooms, as "teachers have generally worked in isolation with high levels of professional autonomy" (Bradbeer, 2016, p. 78), being able to observe other teacher's practices is rare and being watched in practice may be considered challenging (Osborne, 2020). Formal initiatives which bring teachers together to observe and be observed can be valuable. However, it was also found that having high levels of transparency between spaces supported informal observation. These insights highlight how beneficial it can be for educators to be exposed to other's practices and how this can expand and shape one's own understandings of space and practice.

Visual cues. The importance of visual cues to raise awareness of learning environment affordances was recognised through a School A initiative. At this school, most teachers' trials involved attempting to provide more differentiated learning settings by rearranging furniture in traditional classrooms. Teachers recognised that as part of this process they needed to educate their students about the reason for the new learning settings and how to use them. One teacher created posters of classroom layouts to help students 'see' the potential use of the different learning settings. This teacher found that having the poster up on the wall even raised awareness of the opportunities of space to support learning for other teachers. This had a flow-on effect where another teacher who wasn't involved in the research project also used the same poster for her class so that two classes were "doing the same thing in the same room" (Teacher 26, School A).

With more teachers trialling differentiated settings within the same space, the need to revert furniture back to traditional settings after each use was reduced. The School A teacher also found it beneficial to have people around her who were trialling new ideas, including those beyond the research group, as she was able to easily share experiences and get ideas from a wide range of people. This highlights the importance of finding ways to be explicit about the affordances of ILE spaces in order to engage more teachers in thinking about space and practice, paving the way for more collective uses of ILEs into the future.

Student voice. Having a sense of purpose around ILEs was noted in Chapter 5 as critical for teachers to develop the willingness to engage with the change required to use them. Participants noted that hearing student's positive experiences within new types of spaces helped them recognise the value of ILEs. In Study 2, it was felt that teachers generally believed that their purpose was to help students learn, hence when students spoke favourably about new spaces supporting them in their learning, this gave more impetus to teachers to want to use them effectively. One teacher noted:

> I think the biggest insight I've got from it is the girls are prepared to change a lot quicker than we are. And the girls are pretty blunt about their feedback, so they'll be really honest. And I think we're doing them a disservice if we don't let them … be involved in this process as well. (Teacher 27, School A)

Hearing students' perspectives gave teachers better understandings of how ILE spaces supported learning. A number of initiatives trialled sought student feedback via surveys or emails on new spatial settings to assess the success of the initiative. One teacher spoke about how this helped broaden her perspective and gave her more incentive to use new spaces more effectively. She noted:

> I might have my own impression of what I'm doing and how it's working and then the girls come back with something else entirely and I think oh I hadn't seen it that way. So, I think building that in is really critical to our practice … making sure that we listen to what they feel is helping them and what they feel isn't helping them and that we use that information to adjust our practice. (Teacher 36, School B)

These comments recognise the value of student voice to help teachers understand how physical settings can support more student-centred learning contexts. Engaging students in the change process was found to increase teacher's willingness to engage with changing practices required to inhabit new ILE spaces. These findings resonate with McCarter and Woolner (2011) who note that there can be a mismatch between the perceptions of children and teachers, and obtaining student voice on teaching and learning can "enable teachers to reflect on (and improve) their use of physical space" (p. 20).

Trialling and testing practice. Having a research process where participants trialled and tested initiatives, addressing their own felt concerns, gave them deeper insights into the relationship between space and pedagogic practice. The first-hand experiences of teaching in learning spaces with different spatial configurations gave them the confidence to evolve their practice. One teacher noted:

> I feel much more empowered now having done the workshops than I did at the beginning. I think for me when I think about it I think that's been the overall impact is like just try things, have a go, you know, the girls aren't going to not learn anything and you've just got to kind of just take that leap of faith I suppose. (Teacher 36, School B)

It was also noted in Chapter 5 that trialling practices was a powerful way for teachers to learn to work differently within new spaces. The opportunity to engage practically with new teaching and learning experiences, and then to reflect on these in workshops, was found to help teachers overcome their fears of changing the way they did things. The opportunity to 'experiment' with the use of space is uncommon, as in their formal education, teachers are rarely are taught to consider it as a pedagogical resource (Leighton & Byers, 2020). However, as Lackney (2008) notes, knowledge teachers have about how the physical environment to support teaching and learning is likely to be gained from direct experience. The act of trialling initiatives, often with other teachers, and then collectively reflecting on their trials, empowered teachers in the use of space, and reduced concerns around the risk of deviating from current and familiar practices.

Reflections from Stage 1

Phase 4 (Workshop 4) of this study was the culmination of a complete PAR cycle, from reconnaissance to review (refer Figure 34, Chapter 3). Reflections from the final workshop and semi-structured interviews revealed that participants understandings of the pedagogic use of space had evolved. Teachers felt that their awareness of spatial affordances had increased through the research period. In describing the effects of the research process, a teacher at School B noted "when I'm back there (in the traditional classroom) … I'm more conscious of the space even though it's still a traditional space" (Workshop 5 participant, School B). Another teacher noted that the process had enhanced her ability to perceive affordances. Reflecting on the last workshop, she said:

> I felt like we'd come a long way from where we started where it was kind of just like what are we using the spaces for, rather than what could it be

> used for. I think that session allowed me to see the spaces sort of in a new light. (Teacher 33, School B)

Many School B teachers evolved their understandings of how areas within the prototype space were best used over the course of the study. For example, the tiered 'Presentation Space' (refer Figure 67) was originally considered problematic by some teachers as it was considered uncomfortable for students. In some cases, teachers talked about using this space for intensive writing exercises. However, over the course of the research period, they began to recognise that the spatial qualities of the Presentation Space constrained, rather than enabled, this type of activity. If more intensive writing activities for large groups of students were planned, the 'Tutorial Space' (which contains tables and chairs) became more commonly selected (see Figure 68).

The ability to group students close together and sight-lines afforded by the stepped nature of the Presentation Space was recognised as most beneficial for teacher-directed instruction. However, it was also felt that the large area of flat floor space in front of the tiers was conducive to being dominated by teachers. As this teaching approach did not align with the school's pedagogical vision, it was felt that reducing the area of flat floor in this type of space in the future ILE building in development would better direct the activities that took place there. This example shows how a prototype learning space was used to help teachers develop their spatial literacy (Fisher, 2004), and by doing so, aid in the design of future school learning spaces. Through experimentation and use of the prototype space, teachers became more selective of the types of spaces they used for different activities.

The ineffective use of the Presentation Space for writing activities highlights an observation of Gaver (1996) with respect to new technological affordances. He noted that "new technologies seldom simply support old working practices with additional efficiency or flexibility" (Gaver, 1996, p. 111), going on to suggest that instead they tended to undermine existing practices and demand new ones. In the context of ILEs, new understandings about teaching and learning may be required—and indeed anticipated.

Figure 67

School B Presentation space

Note: Image courtesy of Hayball.

Figure 68

View through to Tutorial space

Note: Image courtesy of Hayball.

Enacting new pedagogies was found to be to be beneficial for enabling more engaging learning experiences. School A participants felt that the impact of reconfiguring spaces made a big difference to student engagement. School B teachers also noted that "students took more responsibility" and that "their quality of work had actually improved" (Teacher 38, School B). Seeing these outcomes gave teachers a greater sense of purpose to engage with new ways of working. Participants recognised that the new pedagogies being employed should in fact be used more broadly beyond the prototype learning space. In reflecting on her experience, a School B teacher, who noted that she initially used the same "teach, talk, standing in front of the classroom" pedagogy in the prototype space, now believed that "the pedagogy has to change, but … not just in that space, it has to change even when [I'm] not timetabled in there" (Teacher 37, School B).

One of the felt concerns identified in this stage of the study was the ability for teachers to release control of the classroom environment. Being encouraged to trial new practices enabled teachers to get a feel for a more student-centric environment. Seeing students more engaged and taking more responsibility helped alleviate fears that these types of learning contexts would be hard to control. Reflecting on a propensity for resistance to more student-centred environments, a teacher noted:

> The big fear was if I'm not in a traditional classroom with the class in rows I'm relinquishing my power and the kids are gonna run riot. But what they haven't thought of is you're relinquishing your power but you are giving the kids power and they actually rise to the new situation, they don't run riot, they certainly don't run riot down here … yet you're really on paper much more powerless down here than in the classroom. (Workshop participant, School B)

It was felt that the PAR/co-design research process had empowered teachers to try different ways of working, take more risks, experiment more and not be afraid. A teacher noted "I feel far less afraid of change, I feel like I want to really embrace that change now" (Teacher 36, School B). Teachers from both schools noted that they wanted to continue their explorations into space and practice. However, School B teachers were clearly invigorated by what they had experienced and expressed a strong desire to continue these investigations on their own. A School B teacher who had the professional role of supporting staff in the use of new spaces believed that the energy and depth of thinking that had emerged through the research resulted from a process where teachers had been empowered as co-researchers. She noted:

> I think those workshops and the way that they kind of ran took them to the place that they needed to be in a way that I couldn't do … or not in a way that I couldn't do, but … if I got up at a staff development … they wouldn't have come to that realisation on their own, it would've been me telling them. But I feel like that journey they … came to that point … on their own, they kind of realised that yeah, we need to make that connection. (Teacher 35, School B)

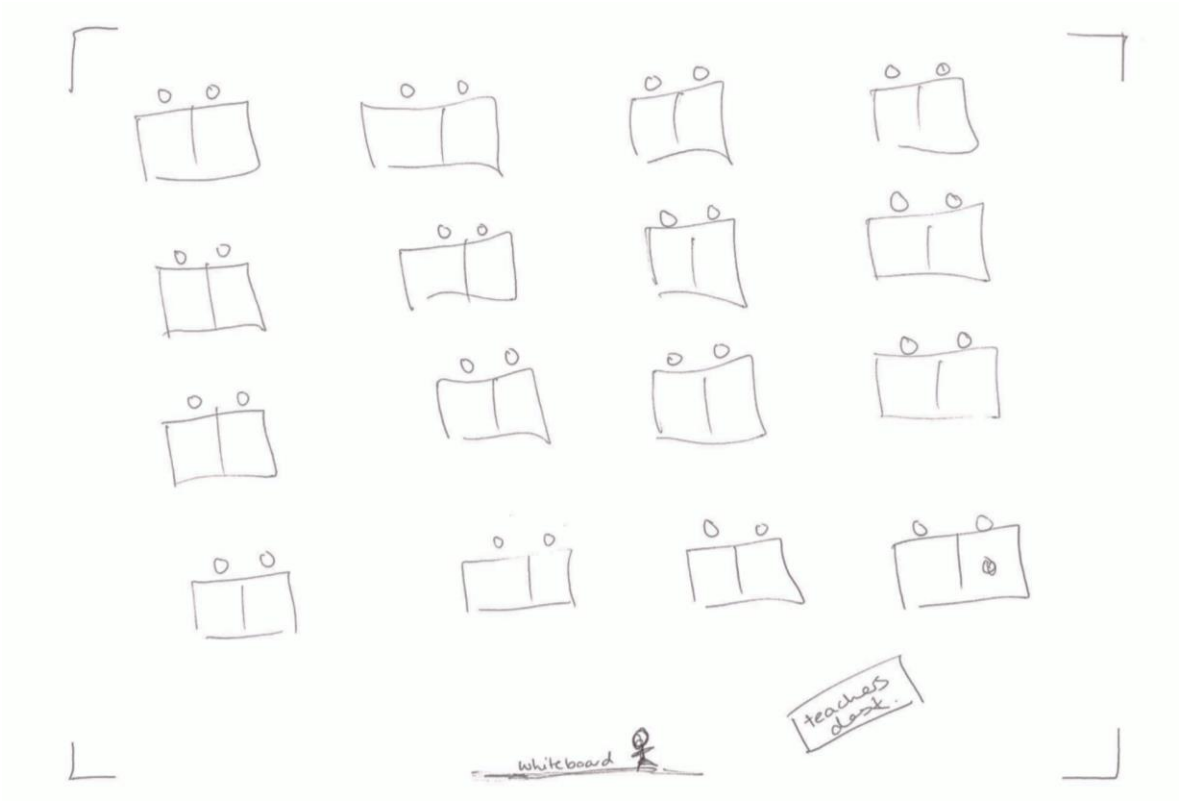
Findings from the study reveal the value of engaging participants as co-researchers to enable them to gain insights into their own contexts, allowing them to evolve their practices. These outcomes align with the intentions of critical theory, critical social theory and critical pedagogy epistemologies which informed the research design. They also align with the work of John Smyth, which centres on listening and 'doing' and eliciting 'local responses' to global issues (Smyth et al., 2014).

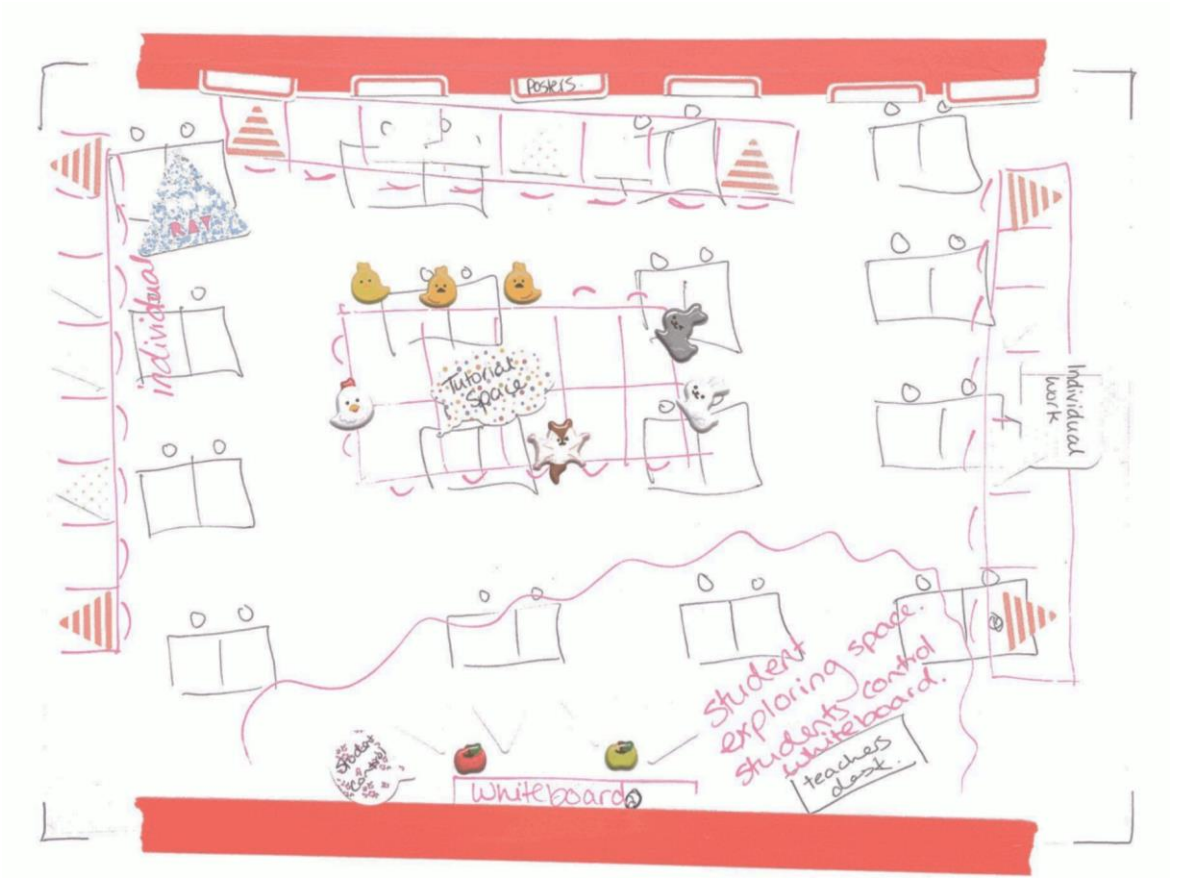
Drawings and discussions from Workshop 4 revealed how teacher's practices had shifted over the course of the research period. Teachers drew representations of what their practice 'was' at the beginning of the research process and what it was 'becoming' — or how it had evolved — over the course of the four-month period. Each teacher drew two drawings—the first drawing, what it 'was'— became the base for the second drawing showing what had changed in the intervening period. Reflecting their different contexts, School A drawings centred around the use of a cellular classroom, and how settings and practices within this had shifted, whereas School B drawings were situated on the floor plan of the prototype ILE space.

School A drawings largely showed an initial traditional classroom configuration with rows of desks facing a teacher by the whiteboard at the front of the room. Additional drawings tended to show more differentiated settings where students could choose to work as part of a group (where desks were brought together to form a larger table) or independently (desks facing the wall) offering students more choices in how they worked (refer Figure 69). Figure 68 also shows that this teacher gave students more control of the whiteboard and posters were put up on the wall as visual cues about the affordances in the space.

Figure 69

Practice shift from 'was' to 'becoming' (School A participant, Workshop 4)





School B participants alluded to evolving to more varied approaches to the use of the different zones in the prototype space (refer to Figure 70). Teachers felt that they were more intentional in their use of space, as shown by the coloured comments in the second drawing. This shows that spaces that weren't previously used (such as the Tutorial room) were being used for more differentiated activities and cross-curriculum activities were taking place around the high table in the Learning Commons. More teacher collaboration was helping overcome issues around lack of time to connect with all students. In addition, this particular teacher noted that she was engaging with less 'teacher talk' and students were taking more control over their own learning. A teacher noted:

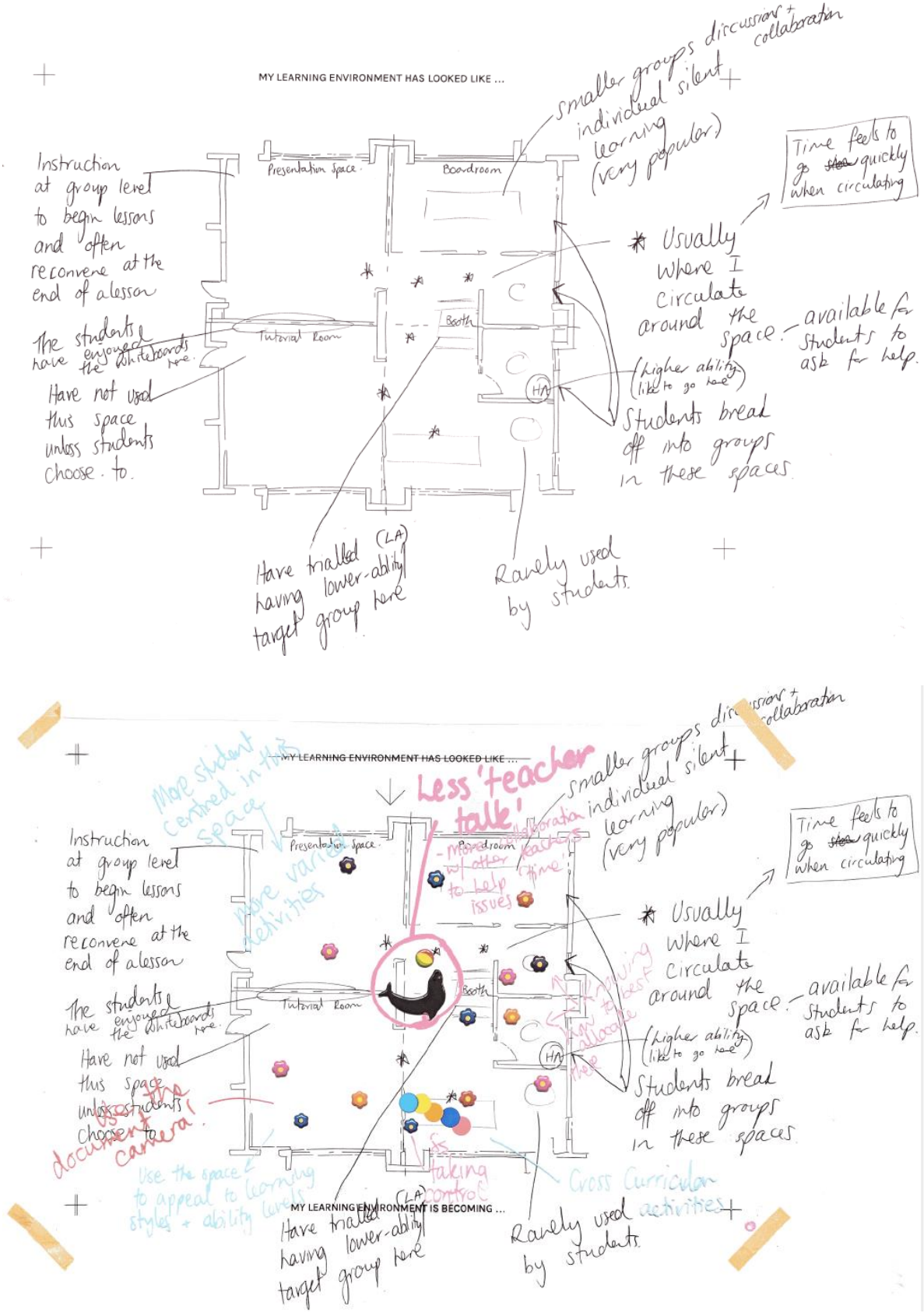
> I've moved a little bit away from kind of that free choice, kind of go with the flow, just use the space, let it be organic. I think I'm a little bit more intentional about where I'm placing kids and who I'm placing kids with ... I've thought a little bit more about the actual teaching and learning rather than letting the space kind of do its thing, you know … the kids will go and they'll do what they have to do. But I think for me … I want to push past that. (Teacher 35, School B)

A much higher proportion of School B teachers expressed a sense of empowerment around practice change than School A teachers. As the prototype ILE already had differentiated spaces, School B teachers were able to focus on honing their abilities to enhance the learning within the space. Through doing so, teachers found that they were more conscious of opportunities offered by the space and decisions they made around how the space was used.

As well as having an ILE prototype space, the presence of the school Principal as a fellow participant also appeared to influence outcomes from the PAR process at School B. Having the Principal join the workshops reinforced for participants the value placed on the practice of change required to transition to new ILEs. It also circumvented any issues arising in relation to practicalities to undertake the research, such as time to attend workshops or trial ideas. In turn, participation gave the Principal insights into how staff were feeling about their new learning spaces and the types of considerations that would be required in order to support the transition (Mackey et al., 2018) into new environments.

Figure 70

Practice shift from 'was' to 'becoming' (School B participant, Workshop 4)



Workshop techniques. As described in Chapter 3, each workshop was hands-on and 'makerly' in nature. This may have been unanticipated by teachers, who were more accustomed to meetings conducted in more conventional ways. In anticipating how a process around the development of spatial literacy might have taken place, a teacher noted "first I was like right … we should get a list and we should just have different activities for different rooms … like something really, um, rigid" (Teacher 37, School B). However, it was found that the more open-ended exploration led to much deeper and transformational outcomes.

The hands-on nature of the workshops brought an element of fun to the overall experience and effectively helped foster a sense of trust and open dialogue between teachers. One teacher revealed that she had initially been reluctant to participate as she was time poor, but that the methods employed in the workshops made the experience engaging. She noted:

> When it became very hands on and real in classrooms … that made it much better … doing hands on activities with these teachers I don't get to spend a lot of time with … that sort of broke down the barriers and got us working as a team. (Teacher 27, School A)

Across workshops, the variety of methods used was positively seen to enable different ways for people to think about and discuss emergent ideas. Collectively agreeing on a series of 'felt concerns' in Workshop 2 was found to help focus the research process and gave participants "somewhere to start" and "build on from there". This aligns with the findings of Meirink et al. (2010), who note that teachers focussed on a shared problem are more interdependent in realising goals compared with when teachers in teams solely work on individual problems. It also helped participants maintain a broader perspective than what they might ordinarily have thought themselves.

Having external members rather than internal school staff facilitating the workshops was also found to be beneficial. Participants noted that generally, professional development was run in-house which could temper how openly teachers engaged in discussions. Noting the propensity to be more guarded in conversations with school leadership, a teacher said "I felt like we could make it work and be more honest. Whereas if that was our boss asking the questions there'd be something behind the answers" (Teacher 27, School A). Atkin (1996) similarly recognises the benefit of the 'outsider', noting that as an outsider one cuts across internal politics and vested interests, making it easier for insiders to accept that their best interests are being acted upon.

More metaphorical workshops (such as Workshop 3 where participants reflected on trials by creating 'outer space' objects to reflect the enablers and constraints of learning

environments (see Research Design, Chapter 3)) had mixed reactions. Some teachers found it challenging to think in this way whereas others enjoyed the creative and playful nature of the exercises. However, the immediately practical value of the workshop was less obvious than it was with workshops where the exercises more directly and tangibly related to the learning spaces. A teacher noted "I had so much fun that session. [laughs] But I walked away and I was like, I don't know if I quite know how to immediately implement that in my classroom" (Teacher 34, School B).

The co-design methods were found to be effective in engaging participants through making, as a tool to support thinking and communication. The ability to play created conditions which helped to foster the team dynamic and build trust amongst the teachers. These techniques complemented the PAR structure of reflection and action, which gave a framework in which to explore practice change. Findings from this first stage of the study were synthesised toward directing the design of a series of tools that were trialled in Stage 2.

Stage 2: Trialling tools for change

This section addresses the process of designing and trialling tools that could help teachers actualise the affordances of ILEs. It also discusses the outputs produced from some of the tools trialled. To explore methods to help teachers utilise ILE affordances, emergent themes from both Study 1 and Stage 1, Study 2 were mapped across the three phases of actualisation (perceiving, utilising and shaping) (see Table 21). Useful characteristics for tools that could potentially support teachers actualise ILE affordances were identified. The tools needed to help users see (perceive) the relationship between space and pedagogical activities and facilitate teachers in the use of ILEs. In addition, facilitating reflections and discussion between teachers would help shape participants further understandings of affordances.

Table 21

Relating actualisation strategies to tools

Actualisation	Key themes/strategies	Potential tool(s)
Perceiving	• Adapt school timetabling to allow teachers time to plan together for working in ILEs. • Visits to see other ILE practices and spaces.	Supports teachers to see the relationship between space and teaching and learning activities.

	• Forums for teachers to come together to specifically focus on pedagogy within ILEs. • Visual cues for how spaces could be configured and used in different ways. • Opportunities for teachers to observe each other's practice. • Student voice in relation to use of new spaces.	
Utilising	• Adapt school timetabling to allow teachers time to work together in ILEs. • Develop a common language around the use of space. • Provide opportunities for teachers to trial new ways of working within existing or new spaces.	Helps teachers develop protocols around common language including: • How to use spaces. • How to teach within the same spaces. • How to work together to ensure students don't slip through the cracks. Provides opportunities for teachers to experience what teaching within an ILE might be like.
Shaping	Reflection and discussion as part of a community of practice about the use of ILEs.	Enables teachers to: • Reflect on their use of space with other teachers. • See other ways of doing things.

It was recognised that it would be difficult to develop a single tool which picked up on the range of strategies identified through this research, therefore, a variety of different tools were tested across two workshops. The first workshop (Workshop 5), focussed on supporting participants in 'perceiving' and the second (Workshop 6), on 'utilising'. While the same two schools participated in this stage of the study, some of the previous participants were joined by additional teachers who had not taken part in earlier workshops. This gave opportunities to observe the influence of the tools on both teachers who already had exposure to discussions about pedagogy and space, as well as others who had not.

Perceiving affordances

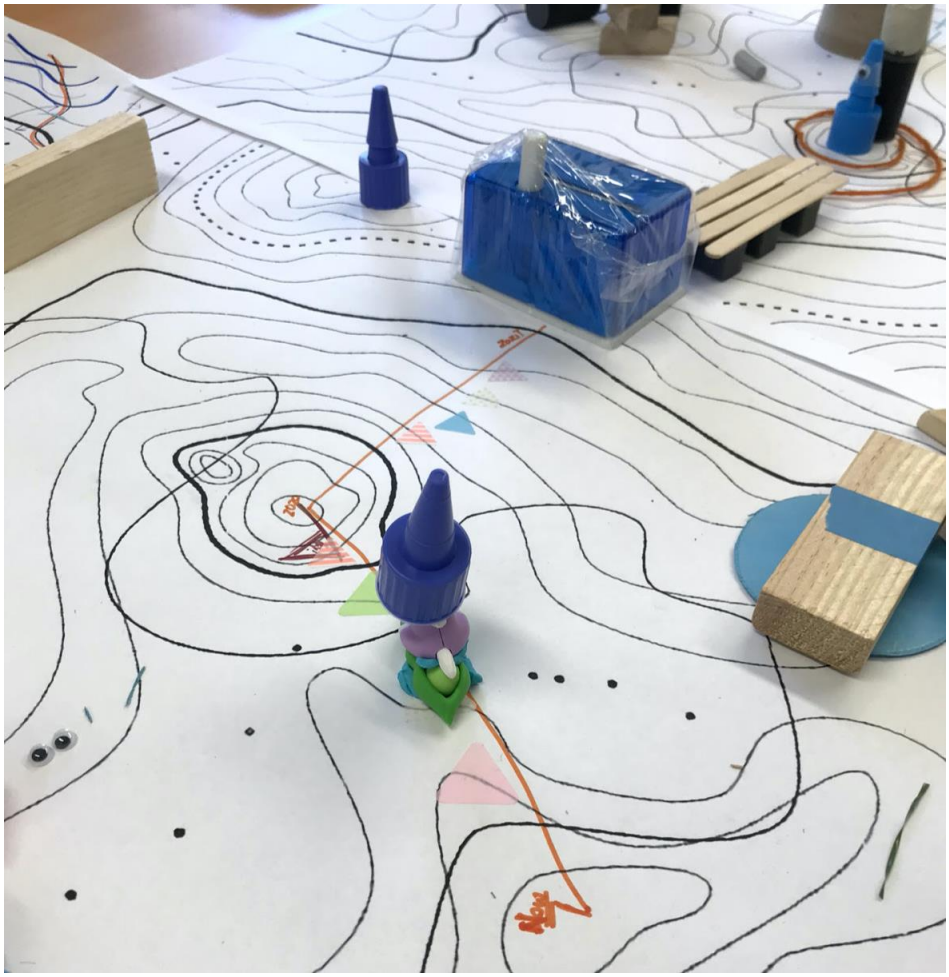
Recognising a need for perception to precede and aid in the utilisation of affordances, the intent of the tools trialled in Workshop 5 was to help teachers perceive teaching and learning opportunities offered by the physical environment. They also intended to help participants think broadly about the influences which shape their ability to use spaces in new ways. As sharing insights and building understandings in discussion with other teachers had already been identified as critical to the process of developing new appreciation for space as a vehicle for learning, tools were designed to support both individual reflection and collective discussion. 'Makerly' techniques were employed again to support participant researchers in this endeavour.

There were three parts to Workshop 5 (refer Figure 43, Chapter 3). The first part was a priming activity where participants were invited to select an avatar from a selection of small objects. The avatar was to reflect the participant's experience in relation to aligning pedagogy with space, and their feelings about their new ILE building in development. For example, one participant selected a group of peas in a pod as it reflected the challenge for her to make lots of parts function as a whole and fit back into the pod. This priming activity also enabled participants a fun entry-point to get to know each other's contexts.

Accessing insights through metaphor. The main focus of Workshop 5 was an exercise involving a topographical map which metaphorically represented the learning environment. From a selection of materials, participants were asked to make an object situated in the landscape to describe their experience of change within the school. They were then asked to locate their avatar into what they had built. One participant who chose the pod of peas as an avatar described her intervention into the landscape as a zip line in which one needed to navigate 'pointy bits' in the experience of developing new buildings (refer Figure 71).

Figure 71

Mapping exercise (School A)



The use of the landscape metaphor helped paint an expressive and vivid picture of the 'bumpy' experience of preparing for a new ILE building. She noted:

> I'm looking at a zip line here between peaks and eventually there and you've got to go from a high point to another high point across where it dips and it's in the wind and it's shaky and bumpy and rocky and, you know, you've got no control in between those peaks … there's all these little pointy bits along the way, you've got to lift your legs up and watch out 'cause … you're gonna hit them if you don't deal with them. And, um, that affects the kids … they've got their pointy bits too because they're trying to deal with what's going on around them as we get from peak to peak and hopefully get to this building. (Teacher 27, School A)

Through this story, the teacher described her role in helping navigate the challenges the school was currently facing with the new building under construction. The 'pointy bits' that

she needed to steer around referred to unexpected problems that she had to address, such as a last-minute location of a new server, disruptions from construction noise, or challenges students faced more generally. Although painted as an exhilarating zip-line experience, an underlying message was the sense of pressure faced in a time of instability and change and the need to support students through it. She continued:

> Basically that's how I feel, like someone says this is your next point, off you go, and it's like I'm hanging on, the kids are coming with me and we're just making our way, we know that there's a safe line there but it just doesn't feel very safe … you know when you take that jump, you're harnessed in, you know it's gonna be OK but it ... just feels like you're hitting every pointy bit on the way and the wind is blowing and everything's shaking and you've got to get to the other end with that smile on your face and your peas in your pod. (Teacher 27, School A)

Using metaphor offered a safe way for participants to share their experiences with others who they may not know well, or typically interact with. Discussing this context in a more indirect manner allowed this teacher to speak in a very truthful way about how she felt about her experience. In this story, the zip line reflects school leadership and the processes put in place in the transition towards their new building. In discussing leadership processes, she notes:

> The zip line is direction from above, it's this is what's happening … this is what's going to happen … and you've just got to strap in and trust in the line. It's that trust in the planning and that there is no break. 'Cause there's been a few times where the line's been frayed along the way because things haven't been considered … they're very big bumpy bits along the way, for what I see as these beautiful spaces that we're going to use. (Teacher 27, School A)

Participants felt that they were unlikely to vocalise some of the things that had been discussed in this session in a more typical staff meeting format. This teacher noted that using a more metaphorical language to communicate takes you away from what you might ordinarily say and "throws you somewhere different and the truth comes out" (Teacher 27, School A). She felt that it helped you understand and nuance your own thinking better and that "your gut feeling comes out and then you recognise that it's there" (Teacher 27, School A). These discussions also made apparent that in thinking about using new spaces, systems and structures needed to be considered in the wider ecological context of infrastructural change.

When leadership was involved as part of this process it added another perspective to the discussions. This enabled teachers to get insights into the challenges the Principal faced during the development of new learning spaces. In discussing the "new shiny building still to be unwrapped" the School B Principal noted (also refer Figure 72):

> It's about, 'How am I going to communicate through this chain and help transition the staff from this to this? I've got these great people who represent a number of people around this room and others who are part of the [prototype space] team who are on different parts of the journey sort of unpacking and looking at different ways to get there and excited and feeling enabled by this space. And yet there's a few of these down here who are scared perhaps or resistant or unsure or want to stay in this kind of model. (Teacher 39, School B)

Figure 72

Mapping exercise (School B)

Participants became conscious of the balancing act needed by the Principal to support the needs of different staff members, all at varying stages and comfort levels around transitioning to a new ILE building. In addition to this was the recognition by the Principal of the need to carve out time to enable staff to be able to use their new building.

> And in amongst all of that at the top of the hill is this clock … time is another challenge for me and creating ways to provide the time for the staff

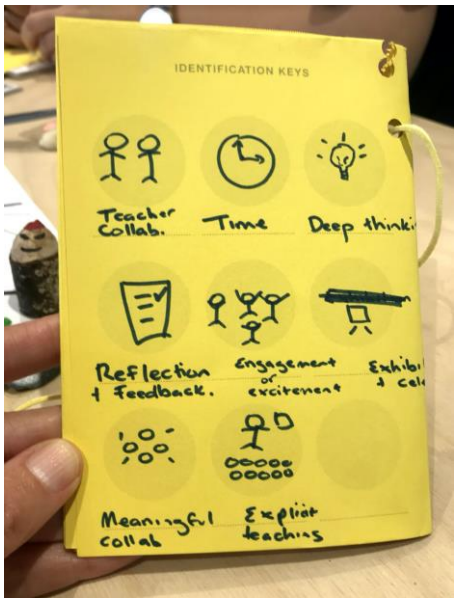
> to sort of be nurtured enough and feel comfortable enough to be able to get to that point. So that it's not just we move into the building and we unwrap it right then and there, that the unwrapping begins before we get there. (Teacher 39, School B)

Having the Principal involved in these workshops meant that there was less of a sense that change was being done to participants and that they just had "to strap in and trust in the line" (Teacher 27, School A), but that they were on the journey together. The Principal's presence gave teachers a sense of 'permission' to engage in experimenting with new practices to prepare in advance of working in the new building together. It also allowed the Principal firsthand insights into the issues and concerns teachers grappled with in relation to adapting their practice to suit an ILE context. This study found that when teachers were invited to participate in discussion with others, including the Principal, about what was 'going on' it helped build trust amongst the group and enabled more openness to discussions and new ideas.

A guide for perceiving affordances. Participants identified a series of action possibilities which they were interested in observing as part of their practice. They listed these in the back of a Field Guide which they created at the end of Workshop 5 (refer Figure 73). In the two weeks between Workshop 5 and Workshop 6, participants were asked to observe these affordances of their current learning spaces.

Figure 73

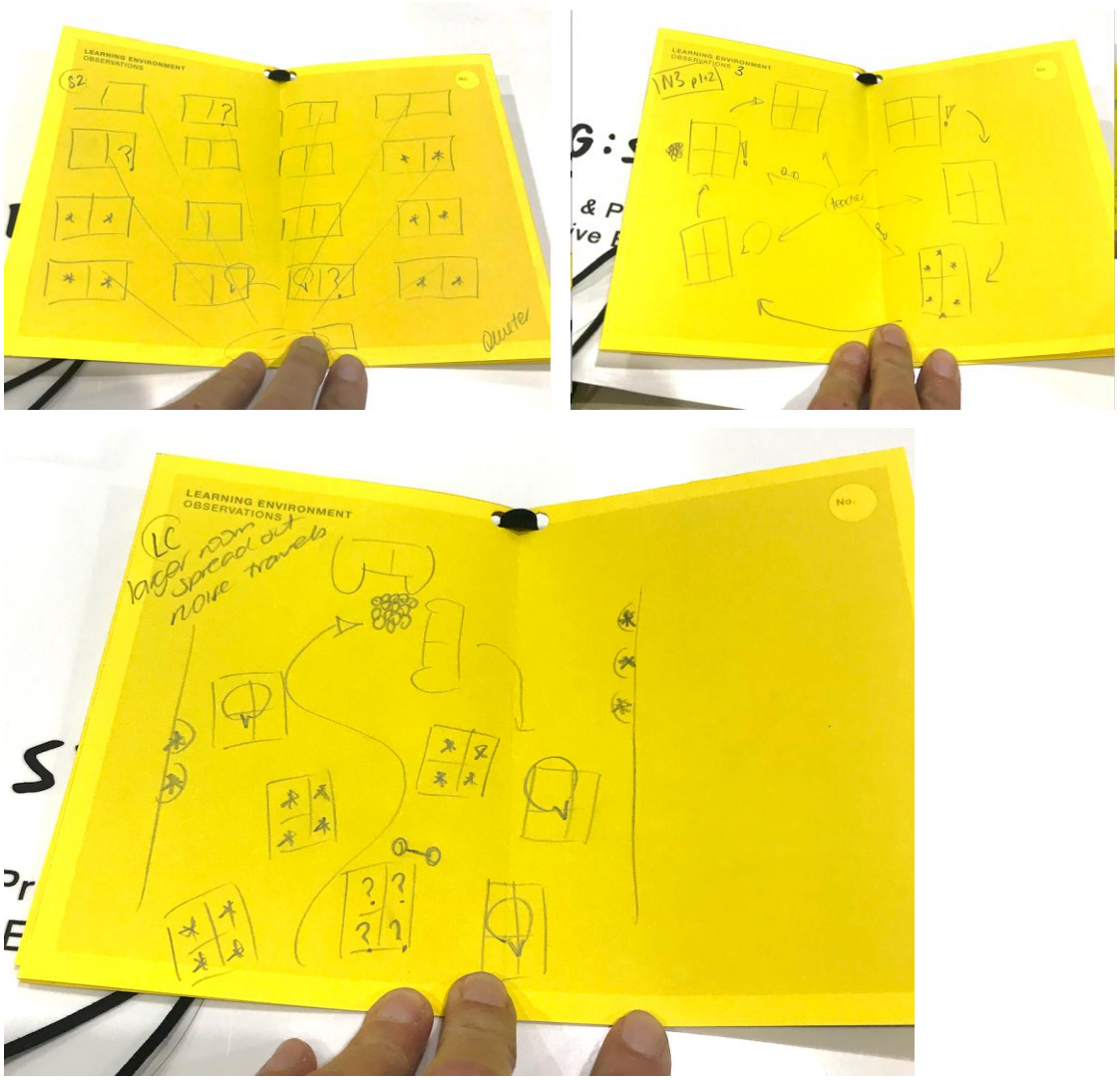
Key to Field Guide



Observations. Using the Field Guide, teachers became more conscious of how the physical environment enabled or constrained behaviours. Many teachers were quite surprised by the different behaviours they observed in different spaces. A teacher from School A who taught in a number of different classrooms was made aware of the influence of furniture configurations on student behaviour. She documented one classroom set up in rows and others with tables clustered in groups or more varied furniture settings (refer Figure 73).

Figure 74

Field Guide observations



In traditional classrooms set up in rows, she described teacher directed scenarios where students had little engagement with each other or the teacher. She noted:

> I found myself a couple of times in classrooms that had rows. The kids came in and they kind of sat down, opened their laptop and they just went *whoosh*. It was when we're like this, this is how we work … no one puts their hand up, no one's making eye contact, I'm talking and guiding them through steps … it was intense. (Teacher 28, School A)

Whereas in the spaces with tables set up in clusters she noticed more collaboration, enquiry and engagement. In describing the clustered scenario she had set up, she noted:

> I had a rotation activity so kids were moving through, you know, workstations, and then there's a greater sense of we're talking as we're learning, we're discovering something new together, we're asking each other if we need some support. (Teacher 28, School A)

The influence of furniture was commonly identified. For instance, couches were recognised to be "a safe quiet space" which better supported small group intervention. A School A participant noted that the intimacy of a couch meant that deeper conversations would take place amongst students. She noted "the way they're sitting no one else can hear the conversation that you're having and they're more likely to ask the deeper questions" (Teacher 27, School A). She also felt that as couches were more comfortable, they were considered spatially less threatening and could facilitate difficult conversations. She felt when sitting side-by-side on a couch it was like "driving in the car" where "you can have those curly conversations 'cause you're not making eye contact" (Teacher 27, School A).

At School B, a high level of detail was recognised around table types. One teacher felt that spaces that had tables that could adapt to accommodate groups of three, four or six students worked well. However, even the large table in the School B Boardroom was found to encourage positive student behaviours. This table was 4 metres long by 1.2 metres wide, designed to seat up to 18 students. The table had a natural plywood finish (refer Figure 75). A teacher noted "there's something about the size of this desk, automatically it's like they develop a sense of maturity in their discussion" (Workshop 6 participant, School B). However, it wasn't just the size of the table that had this positive influence. Teachers felt that even if a few tables were pulled together to be the same size it wouldn't have the same impact. Through the discussion, it was realised that the materiality and finish also made a difference. As a single length plywood table, it was noted that the table 'looks' expensive and that "it probably reminds them of the big board table in a business meeting" (Workshop 6 participant, School B). It was felt that the 'business meeting' setting exuded a sense of "value and importance", hence in the Boardroom, students naturally stepped up in their behaviours and in the levels of responsibility taken in this space.

Figure 75

School B boardroom table

Note: Image courtesy of Hayball.

Upon further discussion, teachers felt that the influence on student behaviour wasn't just a result of the table, but also because of the volume around the table as well. They felt that the scale of the table within the space added to the 'Boardroom' feel. In addition to this, transparency into the space also influenced students' behaviours. A teacher noted that the visibility of the boardroom meant that as this space was used by everyone, when students saw teachers there, they recognised it as a 'grown-up space'. When students used it, they felt that they acted as 'role models for the teachers'. The nature of these observations and collective discussions reveal the shaping of teacher's perceptions of affordances aligning relationships of space, objects and people with user activities and behaviours.

Another aspect identified was the ability for students to move around the classroom during lessons. A teacher spoke about "the importance of movement for social learning" and how often "that doesn't get picked up in a classroom where the control is with the teacher who moves and the kids who sit" (Teacher 39, School B). She noted that the act of standing up or going for a walk was useful to get the blood flowing and helpful for students to think and work through problems. It was recognised that for students coming from primary

schools, which may be more accustomed to learning in more diverse ways, that at secondary school, traditional pedagogies in traditional spaces might "hamper their learning style" (Workshop 6 participant, School B). Through this discussion, School B participants recognised that "it's not just about chairs and tables", but also about "having space around where they (students) can move while they're doing their brainstorming" (Workshop 6, School B participants).

This reinforces insights from Study 1, where 'floor space' was identified by educator participants as an important spatial quality for deep learning. In Chapter 4 the floor was recognised as an affordance for learning. This was a useful insight for architects, who may tend to focus more on the placement of objects within spaces rather than the spaces 'in-between'. Furthermore, when looking at typical architectural floor plans, school clients and educators may not be able to see the potential of these 'in-between' spaces as affordances for learning. Architectural floor plans, whether unfurnished or even furnished, can sometimes be too abstract to be "easily understood by those outside the design and construction disciplines" (Newton, 2009, p. 9).

Given the recognition and value by educators of 'other students' and 'movement' to support learning, architects may need to be more conscious of including people in architectural representations (Young, 2019) to help clients see the relationship between spatial qualities and action possibilities. Including people in plan can give indications of scale and use, as well as movement and flow throughout space.

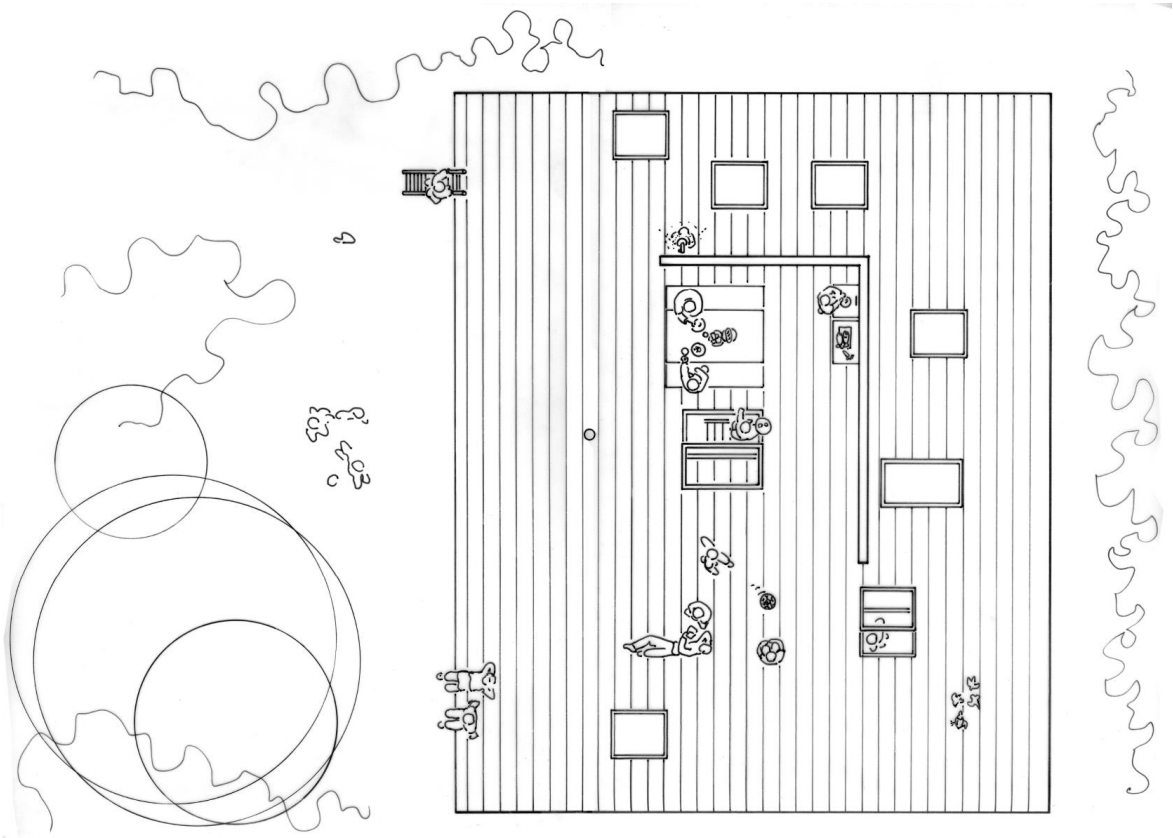
Tezuka Architects in Japan is renowned for their intricate floor plans which involve people engaged in activities. In describing their Roof House, Takaharu Tezuka says:

> We believe that architecture is for people. That is why we always show people in our drawings. In the roof plan, the elder sister is playing soccer and the younger sister is sitting on the edge, someone is showering, and another is having a meal near the kitchen. (Sherman & Logan, 2016, p. 42)

Without these figures shown in the Roof House floor plan (refer Figure 76) it would be much more difficult to sense the experiences that this roof space affords.

Figure 76

Plan of the Roof House, Tezuka Architects

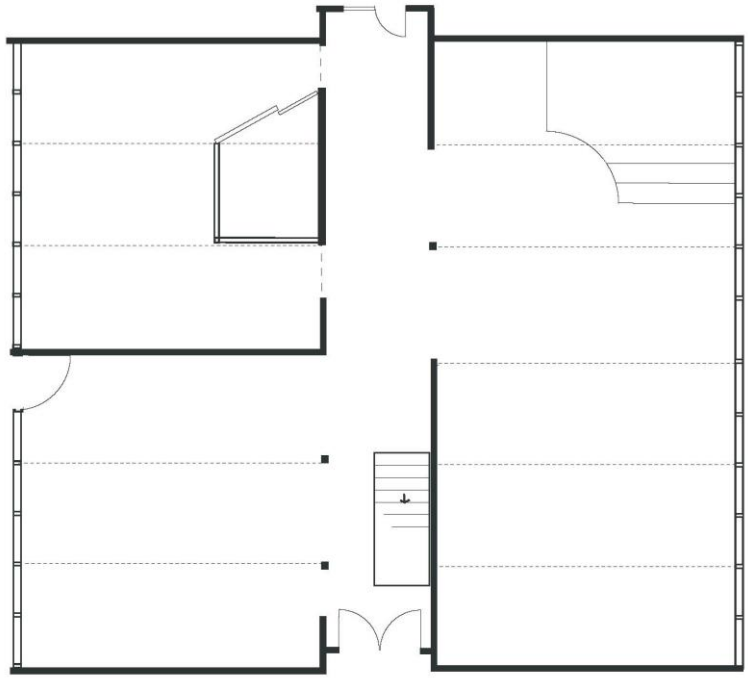


Note: Image courtesy of Tezuka Architects.

Within ILEs which offer multiple affordances for a diverse range of pedagogies, putting representations of teachers and students into plans can not only suggest how spaces can be used, but that these spaces may also enable a range of different uses. Figure 77 shows a floor plan of a primary school learning space. Whilst it shows a general arrangement of space, it gives little indication of the potential activities that might take place within this space. Figure 78 is the same space, yet furnished with a range of seating, table types and storage units. Including furniture gives a better sense of where it's possible to sit, work and store things.

Figure 77

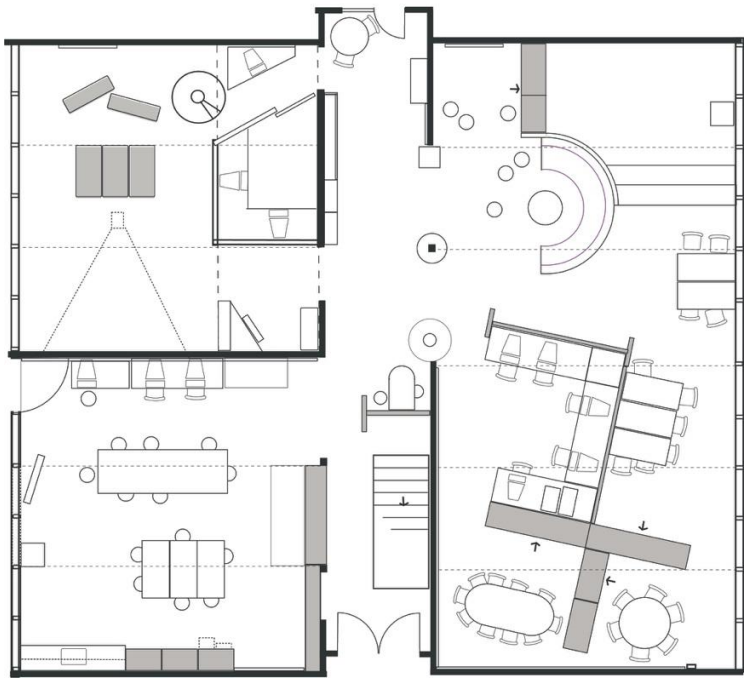
Wooranna Park Primary School (partial floor plan)



Note: Image courtesy of Mary Featherston Design.

Figure 78

Wooranna Park Primary School (partial floor plan showing furniture)



Note: Image courtesy of Mary Featherston Design

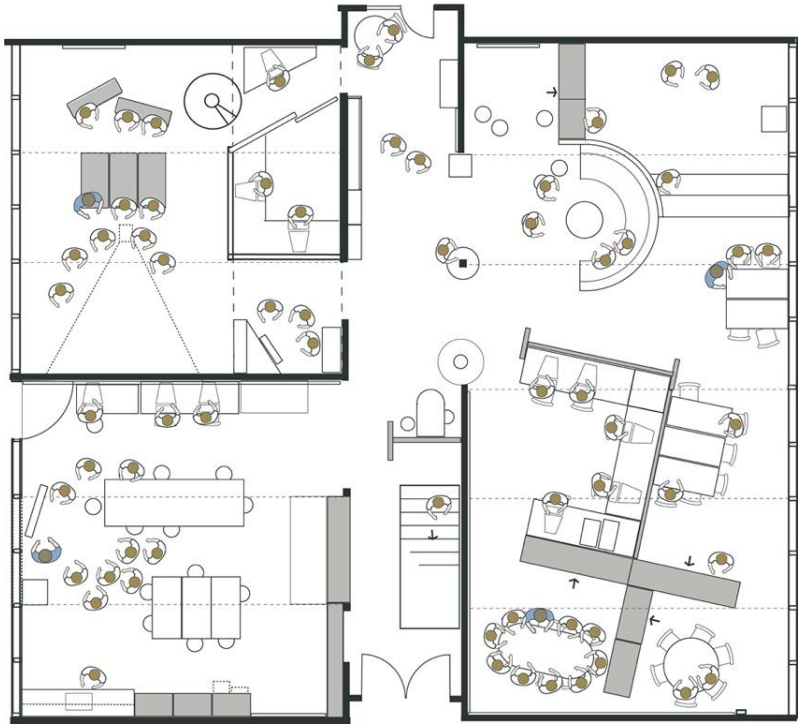
Including people in the drawings (as shown in Figure 79 below) gives a much clearer indication of the variety of activities that are possible. In the first drawing, one group of students and a teacher are watching a presentation. Another group are clustered around a display panel. A large group are working together around a large table and small groups of twos and threes are in various locations around the room. Other students are working independently, some on computers and others at tables. Some are in more quiet enclosed spaces. In the second image, the group that were around the display panel have dispersed and are engaged in a range of activities in the surrounding zone. There are teachers and smaller groups of students dotted around the learning space with some students working together on the floor.

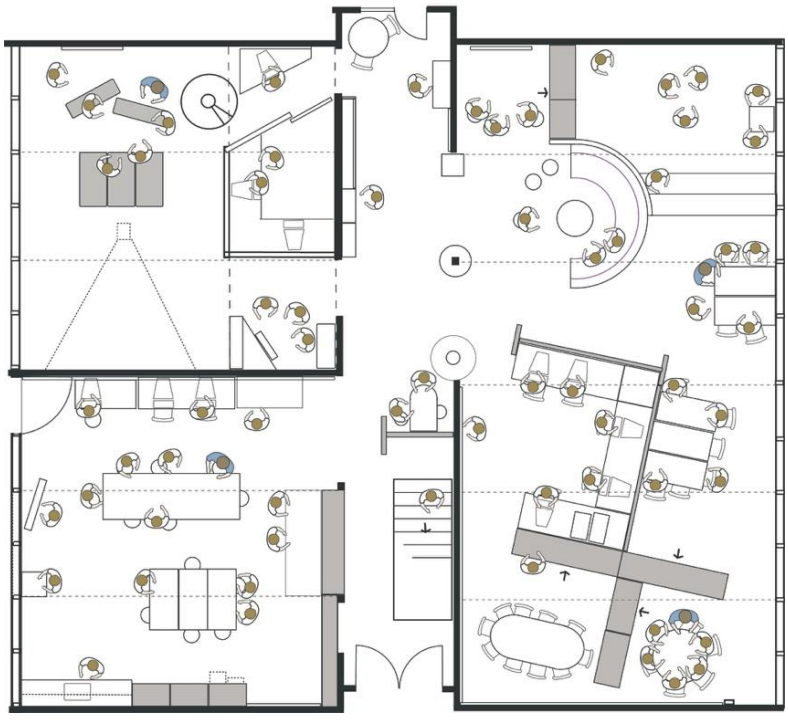
Drawings that include human figures show that the space easily accommodates 64 students and their teachers. Secondly, 'empty' areas which previously may have looked like they were waiting to be furnished are showing that the intention is for the floor to be used as an affordance for collaborative activities. In addition, these drawings show a sense of the dynamicity of a student-centred environment where there are choices of different ways to work. The smaller enclosed area would suggest that this is a quieter space, whereas other areas afford a sense of privacy whilst still feeling part of the larger space. These drawings give a sense of movement within and between various spaces and objects. Recognising students and their learning activities and behaviours as the lens in which educators view their environment, putting people in the picture may help them better see the opportunities afforded by ILE spaces to support this.

The inclusion of human life in floor plans can give a much richer account of the activities, behaviours and ambience intended for and possible within spaces and help align the perceptions of designers and educators.

Figure 79

Two variations of Wooranna Park Primary School (partial floor plans) showing furniture and potential use





Note: Image courtesy of Mary Featherston Design.

Utilising affordances

Workshop 6 culminated in an exercise called *MakingSPACE: Strategies and Protocols to Activate Collaborative Learning*. This was designed to support teachers to utilise the affordances of ILEs and brought together components identified throughout the two studies (Study 1 and Study 2) found to enhance teacher's abilities to recognise and use space as an affordance for learning. The intent of this exercise was to enable teachers to:

- Collectively discuss the potential of their future ILE spaces for teaching and learning.
- Visualise how spaces might be shared and used by a team of teachers and their students.
- Develop a set of shared protocols for the future space around how to use spaces, how to teach within the same spaces and how to work together to ensure students were not overlooked by teachers.

Materials reflecting findings from this research project were used in this exercise. These made up a *MakingSPACE* 'toolkit' (refer Figure 80) which comprised:

- A large floor plan of each school's proposed ILE space printed onto a A0 size sheet of latex synthetic paper with cold gloss laminate. This effectively gave the sheet a whiteboard finish, affording the ability to be able to write and erase when using whiteboard pens.
- A set of whiteboard pens.
- A range of to-scale furniture cut out of yellow cardboard.
- 'Beads' as to-scale representations of students, as well as 'eyeball' symbols reflecting teachers.
- A set of blank yellow 'protocol' cards.

Participants were introduced to the materials in each kit and then invited to play with the pieces. They then 'inhabited' the floor plan with the anticipated number of 'students' and 'teachers' that were proposed to use their future spaces and also selected 'furniture' (Refer Figure 80). They were asked to capture notes on the whiteboard paper of critical points of the discussion that emerged about how the space could or should be used. They were also asked to indicate the types of protocols that need to be developed in order to help them use the space. Toward the latter part of the session, participants were asked to synthesise some of their notes onto the yellow protocol cards (Figure 82).

Figure 80

MakingSPACE toolkit

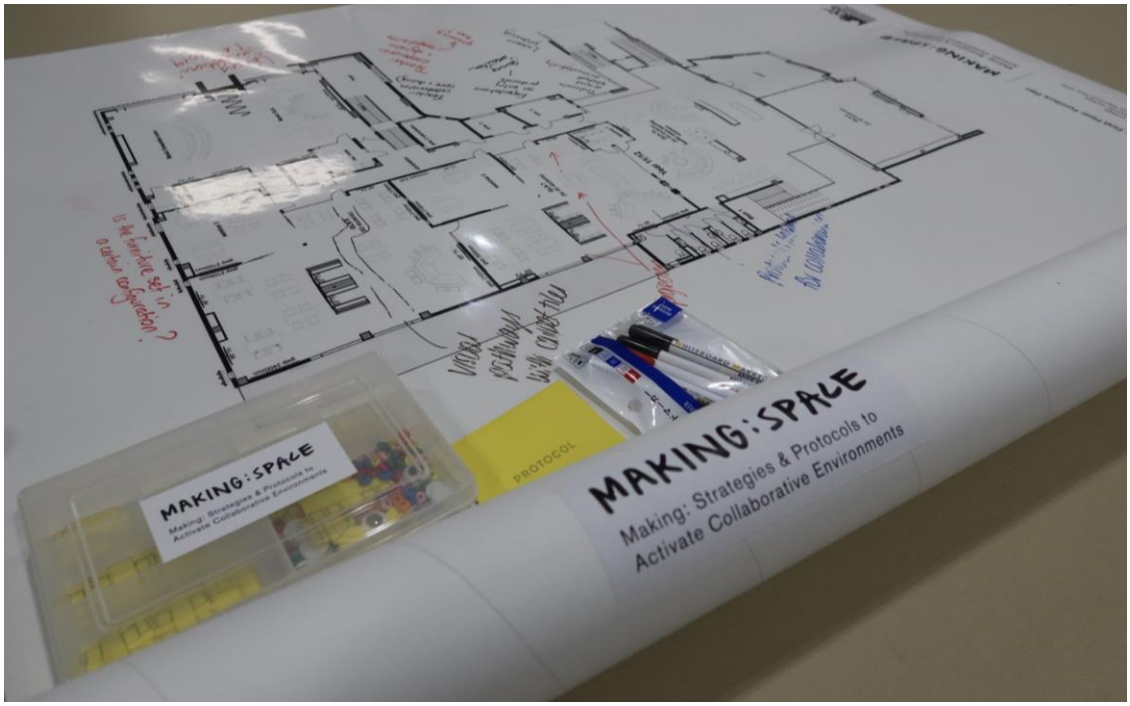


Figure 81

MakingSPACE toolkit in use

Figure 82

Development of protocols within ILE spaces

‘Playing’ with people and furniture on the floor plans allowed teachers to get a feel for how their future ILE would accommodate multiple class groupings at the same time and what some of the constraints might be. Discussions ranged from the details of the affordances in various zones, to levels of visibility allowing teachers to see students, and to how groups might inhabit different spaces. Teachers began to consider aspects they may not have thought of earlier. For example, a School A teacher noted, “it’s interesting, I hadn’t thought about it until now, but in a space of sixty … there’s not enough chairs for everyone” (Workshop 6 participant, School A). A teacher responded, “well not only that but your voice needs to carry across … there’s a whole lot of issues around voice issues” (Workshop 6 participant, School A). These discussions help raise teacher’s awareness of aspects they would need to navigate in using their new ILE space.

Some of the issues raised at School A revealed a conflict with other advice that had been given around using the new building. One teacher noted that at a recent briefing about the new learning spaces they were told that they needed to be able to see everybody and their

screens. Yet this exercise showed that "sometimes … you'll have half the class with their back to you" (Workshop 6 participant, School A). She went on to explain that the way she was trained to teach was difficult to reconcile with these new spaces. She noted:

> This goes back to when I was on prac, the teacher who I had was really conscious of saying when I'm giving verbal instructions that I have eye contact and…this way you're not going to have that. And that you should also not be moving all the time because then your voice carries all over the place. (Workshop 6 participant, School A)

This comment highlights the challenge of using new ILE spaces. As there is a much higher percentage of traditional learning spaces than ILEs within Australia and New Zealand (Imms et al., 2017), teachers are more likely to have been trained to teach within cellular classrooms geared towards direct instruction rather than in using spatially responsive pedagogies within ILEs (Saltmarsh et al., 2015). Furthermore, they are unlikely to have had formal training in the use of space in their education (Leighton & Byers, 2020). This highlights the importance of schools embarking on new ILE spaces to offer professional learning (Cleveland, 2011) geared toward enhancing teachers spatial competency (Fisher, 2004; Lackney, 2008; Leighton & Byers, 2020) to ensure the success of new ILEs.

Protocols for using new spaces. 'Seeing' spaces, objects and people on the *MakingSPACE* floor plans helped teachers perceive the enabling and constraining affordances of their future learning environment. Engaging in this exercise aided them to recognise the types of issues that would need to be collectively understood in using their new building. At School B, a series of themes were captured that could become potential protocols to address emergent issues identified. Aspects which participants felt would help them understand and use their spaces more effectively were broad ranging, from practice-related issues such as how spaces should be used during scheduled class time, to organisational issues including whether students could use them over recess and lunch times.

The themes were categorised into the ecological spheres of organisation, infrastructure and practice (adapted from Lindberg and Lyytinen (2013)) (refer Table 22). Infrastructural themes included both spatial aspects, such as the configuration or set-up of a space, as well as tools that support actualisation. For example, the documentation of an affordance lexicon in the form of 'cue cards', such as seen in Site 3, Study 1 (refer Figure 64) could be considered a tool to support actualisation. Infrastructural themes identified in this study included default spatial settings and the definition of zones for different types of

learning activities and behaviours. Practice related themes related to protocols that supported formal lessons. These included how to get the attention of students or teachers in larger spaces with more people, how people should move through spaces being used by others during scheduled classes, and how students should set up at the start of each class. Organisational themes were high-level and addressed uses of spaces beyond formally structured lessons. They ranged from how spaces could be used out of class time to whether students should be permitted to eat within these more open and self-directed settings.

Table 22

Protocol themes

	Themes	Example of issue
Infrastructure	Default space settings	Will furniture be flexible and light enough to move from lesson to lesson or will there be an agreed way for how the room is generally set up? Should students set up at the beginning of lessons in particular zones or configurations?
	Definition of affordance lexicon	Should we define the use of furniture – e.g. silent tables, talking tables, colour-coded furniture.
	Booking system for spaces	Who's using the small meeting room and when? Is there a system for booking spaces?
Practice	Student protocols around movement, set up and locker use.	How do we move through spaces so that you aren't distracting those already in those spaces? How should students access the common locker/storage without distracting others learning?
	Cue for capturing attention	How would we get student attention? Is there a spot in the room that signifies that attention is required?

		How should students signify they need teacher assistance? Is there a 'queue' on the whiteboard, or a digital dashboard?
	Tracking learning	What is the surveillance system for tracking students?
Organisation	Use of spaces beyond scheduled class time	How and when can students use the spaces at recess and lunch?
	Eating in new spaces	Will we allow eating in the spaces?

No protocols were captured at School A. The workshop duration at School A was shorter than School B due to availability of time, which impacted on participants' ability to think about protocols. Within the given timeframe of the workshops, it was not expected that a complete set of protocols for future use would be developed, rather that the session was a starting point for ongoing discussions. It was anticipated in the design of the *MakingSPACE* tool, that it would be reused multiple times to support schools develop a common approach and language required to suit their particular needs.

'Seeing' how spaces might be inhabited with other teachers helped participants understand the types of protocols they may need to implement to enable effective use of their new ILEs. The *MakingSPACE* tool provided a vehicle for constructive discussions amongst the group fostering a sense of team cohesiveness. This aligns with Meirink et al.'s (2010) comments that "when all teachers are held responsible for contributing to useful artefacts, the level of interdependence increases" (p. 176).

One conversation at School B signified the potential for the *MakingSPACE* tool to be used as part of other professional learning (PL) programs taking place around pedagogy. As the school had an ongoing PL program focussed on Project Based Learning (PBL), a teacher saw the opportunity to deepen staff understandings around the intersection of pedagogy and space by using the *MakingSPACE* tool in PBL training sessions. She felt that the use of the tool could align with practices currently being developed around Project Based Learning (PBL). She questioned:

> Since … we're talking about the rules and what's … got to happen in these spaces, why don't we link those protocols to our PBL protocols? So, if we're talking about collaboration being this type of thing, what would that look like in this space? (Workshop 6 participant, School B)

Teacher's work is centred around curriculum content and pedagogy (Leighton and Byers, 2020). Foregrounding concepts familiar to teachers around learning and using them as a vehicle to think about space provides a tangible portal for educators to shape understandings about the affordances of learning environments. This aligns with Fisher's (2004) suggestion that developing teacher's spatial literacy is best achieved by relating "space directly to changes in pedagogy, curriculum and ICT" (p. 37).

Reflections from Stage 2

Key insights gained from Stage 2 related to the perception and utilisation of affordances emergent from the techniques (or tools) used in workshops. Organisational contexts relating to leadership and the influence of time featured strongly. As well, the use of various forms of prototyping was found to be beneficial in helping teachers perceive and/or experience how pedagogy relates to a spatial context and related affordances.

Leadership. Some of the differences between the types of conversations that took place at the two schools can be attributed to the presence and support of the School B Principal in the research process. For example, when concerns about organisational constraints emerged, the Principal's presence enabled a constructive approach to the discussions rather than a sense that the issues needed to be addressed by others outside of the workshop process. This gave participants less roadblocks to consider when thinking creatively about how to enable use of their new ILE. In one conversation about the difficulty of working differently due to a lack of class time, the Principal alluded to the potential to transition to longer periods. She noted:

> We do have fifty minute periods so there's some conversation happening around what if we did a transition to sixty minute periods and then…if these people are working in a bit of a pod could they then have a separate timetable which might dictate that sometimes they might be two lots of sixty minute periods that form a double. (Teacher 39, School B)

The Principal also discussed the need to change structures to schedule in time for staff working in the new ILE to regularly meet to plan lessons together. These comments were in direct response to reoccurring concerns around time. She noted:

> I'm thinking about the structure of time. So, is there some time built in so that the staff who occupy that space get an opportunity to discuss on a fortnightly basis who and where and how that space will be used?..I don't

> think it could just be a simple matter of we'll timetable it at the beginning of the year into this room or into this space. I think it's gotta be more fluid than what we've currently got. (Teacher 39, School B)

The Principal's presence at the workshops and contributions to the discussion role-modelled an openness and flexibility in thinking required for change in practice. Comments such as these show that the Principal registered the concerns arising in discussion and was processing how these might be addressed. They situate the teachers as co-participants in the process of change, inviting them to equally participate and design how to improve their context to enable their aspirations for teaching and learning within their new ILE. Having engaged and open leadership was found to give teachers the agency to reflect and constructively work toward a new way of working. As noted by Mackey et al. (2018), school leaders "must not only support teachers' professional learning and development but also participate in learning opportunities alongside teachers" (p. 480). Additional benefits are noted by Robinson et al. (2009) who highlight that when school leaders engage in professional learning with teachers, this can significantly impact on student outcomes.

Engaging with co-design. Many participants had not engaged with hands-on methods of thinking and communication before. Some teachers felt a level of discomfort being faced with working in this way however noted that by doing so, they may have "exposed a bit more at a more sophisticated level" (Workshop 6 participant, School B). Participants felt that the methods used in the workshops allowed them to 'better surface unknowns', 'think through nuances', 'link thinking and feeling', 'go deeper', and 'get to the truth'. It was noted that this level of depth would have been unlikely to arise had the workshops been conducted in a more conventional and direct way. Atkin (1996) reinforces the challenge of accessing and articulating depth of thinking in relation to teacher's beliefs. She notes:

> Making explicit what we stand for is never an easy task. Attempts to put into words our innermost thoughts and feelings run the risk of producing statements that sound empty, that do not capture the richness of our meaning. (Atkin, 1996, p. 7)

Atkin (1996) advocates for processes which draw on "intuitive, holistic ways of knowing" (p. 7). The embodied nature of co-design shifts the focus away from thinking toward a more intuitive response, enabling participants to access their 'thoughts and feelings' and to be able to articulate these to others in a safe way.

The techniques used also allowed participants to more readily connect with each other. The act of making, enabled participants to be more playful in communicating with each other, which helped break down boundaries and establish rapport. These hands-on methods used in workshops helped foster collegial relationships and build trust amongst teacher groups. These aspects have been identified as necessary in supporting more collaborative teaching cultures (Wallace, 1999).

However, being invited to 'play' can seem counter intuitive to teachers who are time poor and accustomed to more typical meetings which may have clearer direction and outcomes. Being stretched for time can lead to an expectation to go straight to an outcome or answer, or as noted earlier by a teacher, a more 'rigid' response to how new space should be considered. However, this more direct response may not enable the conditions required for change, which more playful approaches support. A teacher noted:

> Being provoked in this way to play and explore and think, and even though there's a level of uncertainty, I think a lot of those unknowns surface within us that we can feel more comfortable to share that we might not have been able to articulate if we were just going in and saying OK what are your concerns? ... I just think that would've been a bit harder to tap into. And I think this is probably undervalued because we just sort of feel like... with play or thinking or creativity … it's a waste of time. (Workshop 6 participant, School B)

A few School A teachers noted that workshops could have been improved by having less playing time. As noted earlier, School A Stage 2 workshops were scheduled for less time (90 minutes) than School B workshops (120 minutes), which may have hindered an ability to begin to develop protocols from the *Making:SPACE* tool. Being time poor, teachers may have had expectations around gaining more direct 'answers' around the use of space. However, the lack of time in workshops may have hindered the ability to get to a point where teachers appreciated the value of the playful approaches toward changed perceptions around space. For example, a School B teacher noted that through the discussions she learnt that "space can be really anything you want it to be—that there was a lot more fluidity" (Teacher 37).

Indeed, teachers from both schools noted that more workshop time would have been beneficial to the process, and some parts of workshops could have been adapted or removed to improve the process. In particular, some of the more abstract and metaphorical activities were challenging for some participants, either in the activity itself or in linking relevancy to

their own practice in the classroom. For others, these more abstract activities offered creative ways to help think about attitudes to new pedagogies or uncover latent perceptions.

MakingSPACE. Across both schools, Workshop 6 activities were highly favoured by participants due to their perceived 'practical application'. The *MakingSPACE* activity was found to help participants "picture the spaces in the new building" and connect them to their context.

School A participants registered the value of having the visual cue of a large floor plan to help 'see' spaces with other teachers who might be sharing the space with them. Manipulating 'people' and 'furniture' in the space helped teachers understand what would 'fit' into the space. A workshop participant also noted that it helped to see what other people could see. In explaining the benefits of *MakingSPACE* she said: "part of looking at plans … some people can … see what that looks like and some people don't have that capability. But without this at all … you talk about things and it still means nothing" (Workshop 6 participant, School A). This comment alludes to the nature of affordances. That perceiving them is dependent on an individual's intentions and abilities, and therefore what one person sees can be distinctly different from another.

It was felt that this tool was useful as it gave teachers a feel for their new ILE spaces and how they might be inhabited. A School B teacher noted "it was definitely an exciting activity and I felt that everyone was buzzing afterwards as the reality of what we will one day be doing was made that much more apparent to us" (Workshop 6 participant, School B). Teachers from both schools expressed an interest to further engage with this tool, and to replicate this exercise with other staff members.

However, these findings reveal a tension between the value of metaphorical tools that help access deeper insights, with that of tools that more tangibly and directly relate to teachers' contexts (such as *MakingSPACE*). This raises questions about the types of tools that are best employed to support teachers to take pedagogical advantage of the affordances of new ILE spaces. As noted by some participants, they had expected the workshops to involve examples and ideas about how ILEs have been used by others before. Should tools directly reflect ILE spaces, such as through images, floor plans or 3D models? Or by doing so, would there be more propensity for people to want to seek direct solutions: "get a list" and "just have different activities for different rooms" (Teacher 37, School B).

Due to the time frame of this study, tools were only able to be tested once (with each school). Further iterations of tool testing with more teachers from additional schools would have enabled these types of questions to have been explored further. However, it is hoped that this can be investigated further beyond this project.

Influence of prototyping. *MakingSPACE* and the School B prototype ILE are both forms of prototyping. As mentioned earlier (see Chapter 2), Osborne (2020) defines three forms of prototyping typically engaged with in schools: systems prototypes, ephemeral prototypes and enduring prototypes. This study exhibits all three. As a temporary representation of a new building, the large *MakingSPACE* floor plans are an ephemeral prototype. Protocols developed in the course of using this tool are systems prototypes, or non-physical elements of teaching and learning useful to ILEs. Other systems protocols discussed have included grouping students in different ways to trial collaborative learning, teacher observation and 'handing over' the whiteboard to students. Spatial interventions such as rearranging furniture to enable greater differentiation, or dedicated prototype ILE spaces, such as found at School B, fall into the category of an enduring prototype.

All educators in this study highlighted the impact of trialling practices in shaping their understandings of affordances. However, it was clear that having an actual ILE space in the form of a built prototype offered greater insights and more opportunities to test practices than if there had only been traditional learning spaces to work with. Having the prototype ILE space enabled teachers to trial team teaching and gave more opportunities for different pedagogical practices to be observed by others beyond the research group. This benefitted not just those involved in the research but also allowed other teachers and students to see and learn from the activities taking place within the space.

In this way, teachers gained first-hand insights into the potential of space to support practice. These insights then fed into the design of the schools ILE building in development, highlighting how prototype spaces can influence practice as well as inform future facility design.

Strategies for change

The interdisciplinary PAR/co-design methodology gave participants a framework to investigate issues that were relevant to their context and methods with which to explore these. Participants were positioned as researchers of their own practice giving them the agency to

investigate the use of space and be empowered in the process of change. The PAR structure enabled a process for shared discussion and problem identification and the trialling and testing of initiatives was found to be critical in helping teachers learn about new practices within new spaces. These issues were also identified by Meirink et al. (2010):

> Teams in which teachers exchanged ideas for alternative teaching methods and discussed experimenting with these alternative methods, and in which teachers started from shared problem identification, show a large number of learning results. (p. 175)

Combining the framework of a PAR cycle with 'makerly' co-design tools gave participants the freedom to explore ideas, whilst still having an overarching framework to guide them towards the desired outcomes of better recognising and using space.

Themes identified from study 2 around strategies to support teachers to perceive and utilise the affordances of ILEs reinforce and give further insights into what was identified in Study 1 (see Chapter 5). These themes highlight that the nature of practice change is extremely complex and needs to be considered within a holistic understanding of a school context.

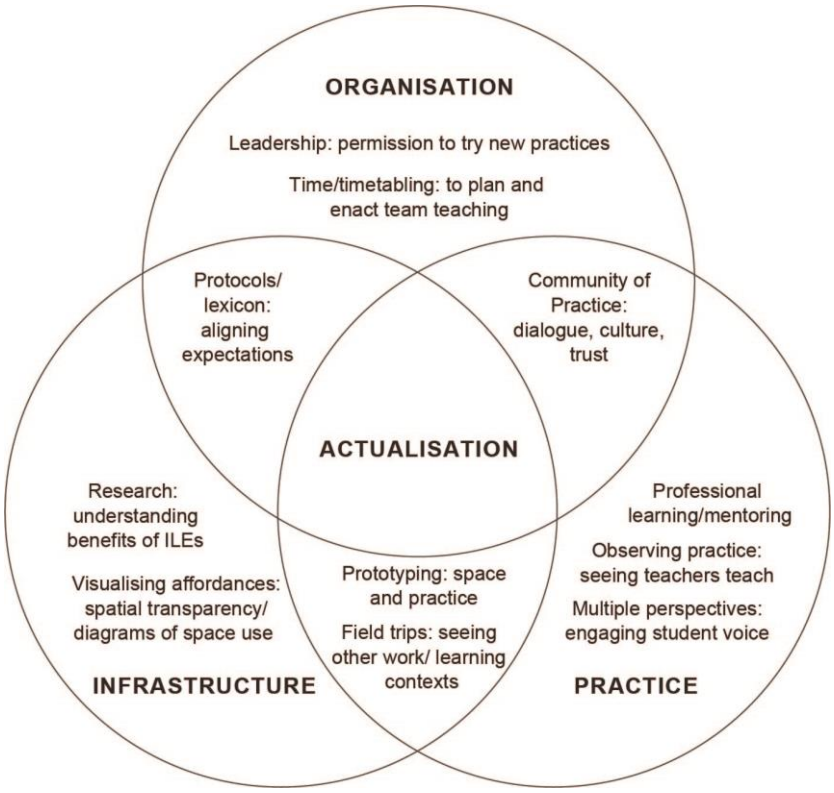
As introduced earlier, Lindberg and Lyytinen's (2013) affordance ecology model offers a useful framework to bring structure to these strategies, grouping them within spheres of organisation, practice and infrastructure. Overlaying key themes found in both Studies 1 and 2 onto Lindberg and Lyytinen's framework (refer Figure 83) shows that the many and varied strategies found to support affordance actualisation relate not only to spaces, or how teachers work within these spaces, but extend to organisational structures that may act as critical enablers (or constrainers). This reinforces the need for schools implementing new ILEs to have overarching structures in place to support teachers through various initiatives in transitioning to new spaces.

From an organisational perspective, the presence of strong school leadership was found to be a critical enabler to support teachers to actualise affordances. School leaders have the power to influence a culture of risk-taking (French et al., 2019) encouraging and giving teachers agency to experiment with new ways of working.

Time has frequently reappeared throughout this research as a significant constraint. The need to allocate ongoing time to establish "routines and conventions, and mutuality between inhabitants" (p. 226) is alluded to by Deed & Lesko (2015), who note that likely differences between teachers understanding of ILEs mean that these aspects cannot be achieved within short time frames.

Figure 83

Affordance ecology framework showing key themes supporting teacher transition to ILEs



Note: Adapted from Lindberg and Lyytinen (2013).

From a practice perspective, communities of practice (Lave & Wenger, 1991; Wenger-Trayner & Wenger-Trayner, 2015) which focus on space as a resource for learning were found to be critical to supporting teachers to enhance their understandings of learning environment affordances. For teachers accustomed to individual practice, collective initiatives involving mentoring and observation of others' practice can be beneficial to 'seeing' new ways of doing things. Other practice-related strategies include field trips to schools or innovative workplaces to be exposed to innovative practices and spaces. Seeing and hearing student's perspectives has also helped teachers better understanding the potential benefits of ILEs giving them greater purpose in the process of change.

From an infrastructural perspective, access to research on the benefits of ILEs for learning was also found to influence teachers sense of purpose around practice change. Other elements, such as a common language and the presence of protocols help align expectations

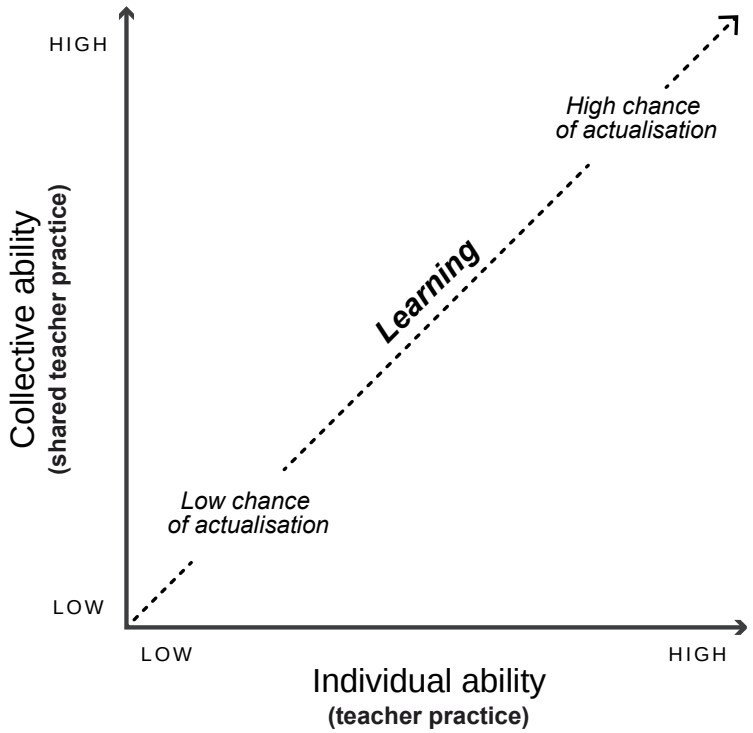
around the use of spaces. The development of an affordance-based language around space use supports Heft's (1988) view of the need for common understandings of the functionality of space. Finally, prototyping (Osborne, 2020) both space and practice can aid teachers in perceiving and utilising the affordances of new ILEs.

Achieving the aspirations set out for ILEs is dependent on teacher's individual and collective abilities to perceive, utilise and shape the affordances of ILE spaces. Strategies should be considered to not only shape teacher's individual abilities to use space, but also collective abilities to work in these spaces together. To this end, Mackey et al. (2018) note that when teachers collaborate with others, individual teacher performance improves which has flow on effects for student-achievement. Furthermore, as Meirink et al. (2010) notes, "in a group with a high level of interdependence, the teachers learn more than teachers in a group with a low level of interdependence" (p. 164). Higher levels of interdependency involve the regular sharing of instructional materials and ideas, and joint work with collective responsibility.

Figure 84 shows an indicative diagram which indicates this concept around the importance of enhanced individual and collective ability in using ILEs. If an individual teacher has high spatial literacy around affordance actualisation, yet shares spaces with others with low ability, then the overall chances of this individual optimising the use of affordances are reduced due to a lack of overall structure and understanding around shared use. On the other hand, if collective understanding and ability around the use of affordances is high, then this increases an individual's chances of being able to actualise affordances. This reflects the need for groups of teachers sharing spaces to embark on a process of learning together to help shape individual and collective understandings of affordances.

Figure 84

Affordance actualisation relative to individual and collective teacher practice



Conclusion

While there is increasing interest in the potential of ILEs to support more diverse pedagogies in support of deep learning, less awareness or understanding exists about how to support teachers' transition into new spaces. This study revealed that with supporting structures in place, including ongoing workshops through which to generate individual and collective insights into the affordances, or action possibilities, of new spaces, that teachers could become comfortable exploring 'new' pedagogical approaches and working more closely with colleagues—and avoid a propensity to revert to default teaching practices developed through long-established experience and understandings of traditional classrooms.

Considering learning environment affordances within a wider context (i.e. beyond direct human-environment relations) was also found to be important. To this end, the adoption of the 'affordance ecologies' framework proposed by Lindberg and Lyytinen (2013), which incorporates infrastructure, organisation and practice dimensions of affordances, is suggested as useful in bringing people's attention to both spatial and non-spatial dimensions, such that may influence affordance actualisation within ILEs. Indeed, this research identified that many non-spatial matters had an influence on teachers' practice

change in ILE spaces. These matters included organisational issues, such as timetabling, time for planning, trialling and testing new practices, and opportunities for communities of practice to meet and reflect.

In this study, the presence of strong school leadership was found to be impactful to the change process. It signified to teachers that the work of transitioning practice toward new ILE spaces was important and gave participants insights into issues being grappled with at leadership level as part of the transition. This created a culture of transparency and trust, invoking the sense that rather than change being imposed top down, that participants needed to work together to enable the changes required to transition to their new ILE spaces. The presence of leadership also circumvented logistical issues arising in the research discussions and by doing so extended the sense of permission for participants to engage in new practices.

Transitioning from teaching in individual classrooms to larger shared spaces with multiple teachers and more students requires common understandings about how the affordances of ILEs can be used for a wider range of pedagogies than possible within traditional classrooms. It was found that a shared lexicon could support teachers' and students' understandings of the expectations of space.

Tools that were developed and tested in this study relate to some of the strategies identified through the research process. It was found that different types of tools best supported different parts of the process of perceiving and utilising, toward affordance actualisation. A tension was recognised between tools which supported deeper insights into practice change and other tools which supported the practicalities of shared practice within shared spaces. However, rather than developing 'a' tool to support transition to ILE spaces, a range of tools appear to be required to support different stages and aspects of the process of affordance actualisation and transition. Further studies could focus on the development and testing of tools to support teacher observation or obtaining student's experiences of ILE spaces. Other studies could also further explore prototyping as a vehicle to support practice change.

Finally, this study revealed how shifting teacher practice requires ongoing and concerted effort and time. Critical to empowering teachers to actualise the affordances of ILEs in support of student learning is providing them with the time and space to collectively develop their practice with other teachers.

Chapter 7. Conclusion

Introduction

In this final chapter I re-visit the research questions, provide a brief summary of key findings (as presented and discussed in Chapters 4-6), and discuss additional insights that emerged from synthesis of the findings in relation to the literature. The research questions are re-stated below:

- What are learning environment affordances? How are they perceived by educators and architects?
- What factors enable teachers to actualise the affordances of learning environments?
- How can teachers be supported to actualise the affordances of ILEs for deep learning?

In drawing together my conclusions, I discuss implications of the research for architects and teachers, and reflect on the research process, identifying limitations and suggestions for further research.

Summary of the research findings

Following a review of the literature, my research comprised two distinct phases of fieldwork. Study 1 focussed on understanding *what* affordances educators' and architects' perceived across five case study educational facilities. This also involved an initial exploration of *how* educators perceive the action possibilities of their environments. This initial phase led neatly into Study 2, an iterative participatory action research (PAR)/co-design study that involved working directly with teachers from two schools to learn how they perceived and actualised learning environment affordances. Based on earlier findings, tools to help educators actualise learning environment affordances were developed and tested as part of the research.

Positioning learning environment affordances

As noted earlier, affordance theory originated in psychology, where it was developed by Gibson (1979). Since then, it has been applied and re/interpreted within other fields including technology, human-computer interaction, anthropology and children's environments. Over the past forty years, affordance theory has been less present in discourse within the built environment fields, including architecture, interior design and learning

environments. Hence, it was important to position affordances within the context of this study and learning environments research generally.

In positioning affordances for the purposes of this research, I reviewed key ideas relating to the theory (See Chapter 2). These were then situated and discussed in the context of learning environments (refer Table 23).

Table 23

An affordance terminology for learning environments

Terminology relating to affordances	**From**	**Terminology relating to learning environment affordances**
Environment	Gibson (1979) Kim et al. (2007)	Qualities of the environment which include space, objects and people.
Relationship	Gibson (1979)	Complementarity between the environment (space, objects and people) and users (teachers and students).
Action possibility	Gibson (1979)	Activities related to teaching and learning.
Perception	Gibson (1979) Norman (1988, 1999) Gaver (1991)	Recognition of potential teaching and learning activities and behaviours offered by space, objects and people within the environment.
Actualisation	Heft (1988, 1989) Kytta (2002, 2004)	Perceiving, utilising and/or shaping (learning) an affordance.
Ability and intentions	Warren (1984) Norman (1988, 1999) Heft (1988, 1989)	Capabilities (either physical or mental) of a user (teacher or student) to enable affordance actualisation.
Socio-cultural context	Norman (1988, 1999) Gaver (1991) Heft (1988, 1989) Costall (1995) Rietveld (2014)	The ‘form of life’, or a schools organisational and cultural context, in which teachers and students are situated.

Learning	Gibson and Pick (2003) Heft (1988, 1989) Kytta (2002, 2004) Lindberg and Lytinnen (2013)	Developing teachers' and students' abilities to actualise affordances.

In the literature, objects such as door and cup handles (Gaver, 1991; Kaptelinin, 2014; Koutamanis, 2006; Rounis et al., 2018) have typically been used to illustrate the direct human-environment relationships associated with affordances. However, these object-based examples do not capture the spatial environments (Atmodiwirjo, 2014) in which these objects are situated. Nor do they recognise the affordances offered through interactions with other people within spaces (Kim et al., 2007). Hence, in the architectural context of this study, the term 'environment' more inclusively refers to elements of space, objects and people.

Although there are a range of stakeholders associated with schools, the primary users of learning spaces are teachers and students. Therefore, tailored to the school context, the action possibilities arising from the complementarity of environment and user relate to the teaching and learning activities and behaviours that may take place. Teachers' and students' physical and mental capabilities (abilities and intentions) will influence whether or not they perceive and utilise affordances. So in any given school environment, there will be an array of spatial qualities that may offer an affordance for users, however, unless individual teachers and students recognise these, they may remain latent in the environment.

Drawing these elements together, the definition for learning environment affordances developed for this research is *"qualities of the environment (space, objects and people) which may be perceived to enable teaching and learning activities and behaviours"* (Young et al., 2019, p. 5). Picking up on the immersive nature of the built environment, this positions affordances within an architectural context. Qualities of spaces, objects or people may enable action possibilities for teaching and learning. However, whether the qualities are used (or not) is dependent on whether or not they are perceived by users. This definition brings together the critical element of perception, required to activate affordances, with the environment and its action possibilities.

The distinctive affordances of ILEs

A few researchers have identified common features associated with ILEs. These have included variables associated with size and scale, flexibility of space, furniture and activity settings (Alterator & Deed, 2013; Cleveland, 2018). The taxonomies of affordances emerging from this research (Study 1) articulate a greater level of detail regarding the spatial qualities of learning spaces—and of the action possibilities they present—when compared with what has been reported in earlier studies. The more comprehensive listing of affordances in Chapter 4 (see Table 13), shows 43 different learning environment affordance types.

These affordance types were categorised into six groups: general; zones; finishes/fixtures; furniture; digital technology; and people. Within these groups, each affordance was defined as a relationship between a spatial quality and an action possibility, highlighting what it is about the physical or digital environment that enables particular pedagogical activities. Associated with each affordance, the study found examples of different ways that they could manifest. For example, smaller defined areas which enabled small group, individual and independent work could take the form of an alcove, recess, nook or booth. This suggests a more functional-based approach to discussing aspects of the environment, as promoted by Heft (1989), rather than the typical form-based approach typically used within architecture (Maier et al., 2009). Using language in more functional terms, minimises the risk of miscommunication between parties and better ensures the likelihood that both designer and user have common understandings around the intended use of spaces.

As recognition of affordances may differ between different people, additional learning environment affordances are likely to be identified in future research. It is hoped that the taxonomies of affordances that emerged from this research will be expanded by others.

In addition to identifying specific affordances, a number of important general findings also emerged from this research. Firstly, it was identified that more affordances for learning were perceived in ILE environments than traditional classrooms (see Figure 46, Chapter 4). This was attributed to ILEs having larger spaces, more well-defined zones, spatial openness, varied furniture, multiple points of focus, the capacity to reconfigure spaces, and access to a range of digital resources. This finding reinforces the view that by offering a wider range of spaces, the design of ILEs is intended to enable a wider range of pedagogies than traditional classrooms (Byers et al., 2014; Carvalho et al., 2020; Cleveland, 2011; Dovey & Fisher, 2014; Imms, 2016a; Leiringer & Cardellino, 2011; Woodman, 2011; Woolner et al., 2007).

Secondly, more affordances were identified in primary than in secondary school spaces. This was found in both traditional and ILE typologies (Dovey & Fisher, 2014). The variation between spaces at different levels of education reflect not just the physical contexts, but also practices which take place within them. At primary school sites, there were a greater variety of zones for different activities as well as more breadth of subject-matter and ways of engaging with it, than in secondary school spaces.

Thirdly, the study identified specific qualities of ILEs that supported specific teaching and learning approaches (see Table 15, Chapter 3). Having a range of different settings to enable diverse learning activities was perceived by participants to be beneficial across pedagogical approaches, which included team teaching and collaborative, interdisciplinary and deep learning (Fullan & Langworthy, 2013; Mahat, Bradbeer, Byers, et al., 2018).

Other spatial qualities, such as larger (than traditional) spaces, or outdoor spaces, were more aligned with only one or two of these teaching and learning approaches. For example, larger spaces were identified by participants to specifically align with team teaching and interdisciplinary learning.

Dedicated spaces for teachers to collaborate and plan programs were also seen to be extremely important to support team teaching. Whereas it was found that having wet areas with more durable finishes for more hands on and exploratory activities, and spaces that could be changed and used in different ways, was specifically aligned with the needs of interdisciplinary learning.

These nuanced distinctions offer valuable insights for designers and users into how space can enable or constrain different pedagogical activities and can be applied to the design process. For example, when schools aspire to collaborative teaching and learning behaviours, or more interdisciplinary practices, spatial qualities such as size, diversity and flexibility, as well as inclusion of wet areas and dedicated areas for groups of teachers to collectively work should be central to the project brief and ensuing conversations that take place in the development of the design.

The lenses of architects' and educators'

A fourth key finding related to the difference in perceptions of those from teaching and architectural professions. Whilst many affordances were perceived by both professions, educators were found to perceive more affordances overall than architects (see Figure 46, Chapter 4). This revealed that educators were recognising more detailed affordances, aligning

with Koutamanis' (2006) view that architects are commonly less successful at sharply defining activities in the built environment due to the complexity of human activities better known to inhabitants.

Some affordances were recognised only by educators. These included floor spaces that afforded gathering of large or small groups, and the presence of other students with whom to interact, discuss ideas and work along-side. Recognising that these affordances were not identified by architects highlighted that they have the potential to be overlooked unless consciousness is raised about their action possibilities. For example, for a designer, considering the floor as a useful space for students to gather and work on, rather than purely as a surface to house furniture, may influence decisions around materiality and/or the addition of environmental graphics as visual cues.

Another difference observed between professional perspectives was in relation to beliefs about a hierarchy of spatial qualities that enable deep learning. Deep learning practices are commonly recognised as 21st Century skills, which include communication, collaboration, critical thinking, creativity, character education, citizenship and problem solving (Fullan & Langworthy, 2013). These skills have been identified as critical for success in our current rapidly changing world (Fullan et al., 2018).

Architects felt that the most important qualities for deep learning were environmental aspects such as natural light, ventilation, air temperature and sound absorption. In comparison, educators felt that places that groups of students could work together, digital resources, and the ability to change spaces for different practices (or merge different activities) was of most importance. These responses revealed a potential tension between the professions in relation to what spatial qualities need to be advocated for in the design of new school spaces.

The reality is that the views of both parties are valid. Environmental aspects relating to 'naturalness' have been identified in a major study by Barrett et al. (2015) as a significant contributor to student learning outcomes. However, the ability for students to work together in different ways provides opportunities to enhance skills in collaboration. Recognising the importance of all of these aspects will help ensure that both parties are aware of the different ways the physical environment needs to support deep learning approaches so that decisions about potentially competing requirements can be made in a more informed manner.

Although both architects and educators felt that poor acoustics was a major constraint to learning, it is curious to note that teachers did not identify sound absorption at all as a critical enabler of deep learning. This may relate to how architects perceive their ability to

influence space, whereas in comparison, teachers may feel they need to address environmental issues through their practices. For example, teachers spoke about allowing students to wear headphones to block out sound or how they adapted to 'shutting out' elevated noise levels. This finding highlights the complexity of sound, noise and acoustics and the need to raise more consciousness amongst school clients and designers around the impact and influence of sound and acoustics on teaching and learning practices and activities.

Actualisation within a 'form of life'

As noted in this research, affordances of ILEs are actualised based on teacher's and student's perceiving them. Teacher's abilities and intentions around the use of space as part of their practice was influenced by their broader socio-cultural contexts. A number of researchers have noted the influence of socio-cultural contexts more generally on people's abilities to actualise affordances (Costall, 1995; Gaver, 1991; Heft, 1988, 1989; Norman, 1988, 1999; Rietveld & Kiverstein, 2014).

Rietveld & Kiverstein (2014) describe socio-cultural contexts as part of 'forms of life', or regular patterns that manifest in the normative behaviours and customs of communities. In this research, school's varying forms of life, were found to influence teacher's abilities to the use new spaces. Multiple forms of life were also seen to co-exist influenced by a range of factors (see Figure 85). At school-wide level, school leadership was reported as core to enabling a culture of experimentation and risk taking (French et al., 2019; Saltmarsh et al., 2015) allowing teachers to practice in new ways. Leaders had the power to adapt organisational structures such as timetabling, giving teachers the time to work with other teachers to prepare to teach together.

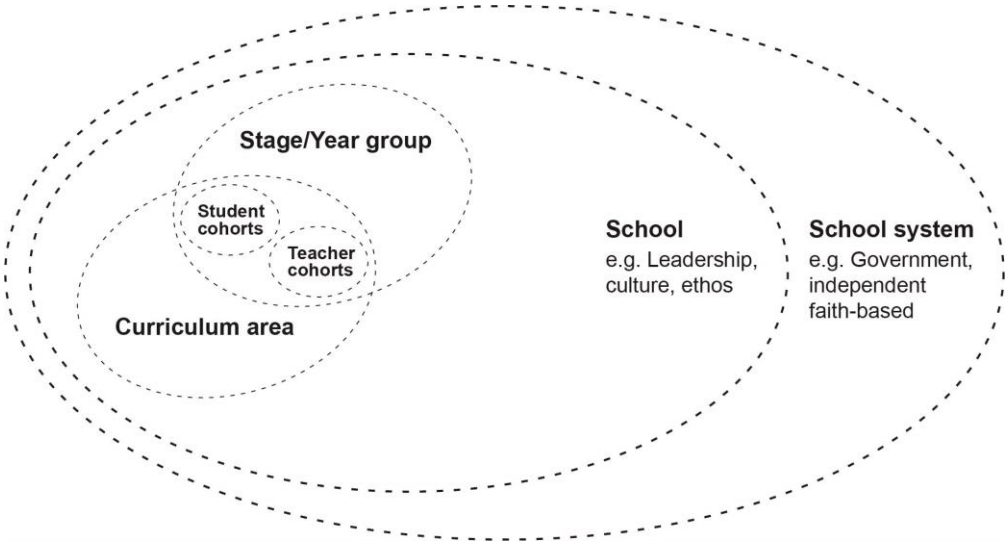
Teachers who taught at different stages of education also operated within distinct forms of life. For example, primary school teachers were found to be more accustomed to collaborative teaching and learning practices than secondary teachers. As well, teachers from different curriculum areas had varying understandings around how things could be done, which highlighted the benefits for teachers to connect across key learning areas for exposure to other ways of thinking about space and practice.

Even within these spheres, variation was found amongst teacher (and student) cohorts, from 'innovators' (Rogers, 1995), who were eager to try new spaces, to those less comfortable with change. Overarching systemic policies around pedagogy and learning spaces are also likely to influence a school's form of life. Whilst some of the schools in this

research belonged to educational systems known for advocating for ILE spaces, this study did not specifically explore how differing schooling systems might influence teacher's abilities to actualise affordances.

Figure 85

Aspects of the 'form of life' of a school



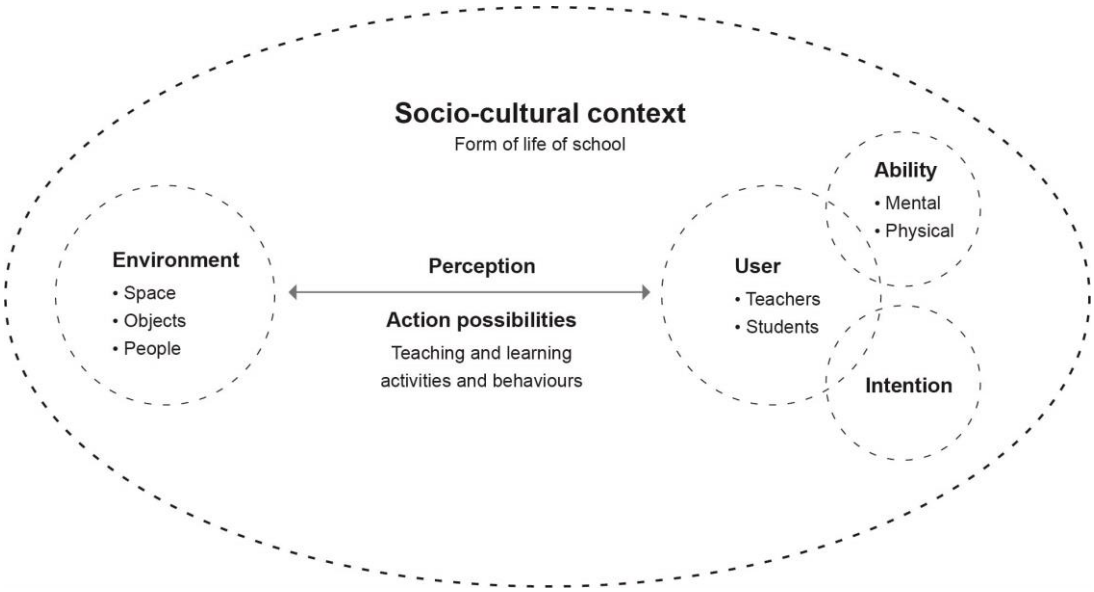
Teacher's abilities and intentions to actualise affordances can be shaped through learning (Gibson & Pick, 2003; Heft, 1988, 1989; Kyttä, 2002, 2004; Lindberg & Lyytinen, 2013). However, such learning may be influenced by the forms of life (Rietveld & Kiverstein, 2014), or the socio-cultural contexts of the schools within which they operate. Hence, a fuller appreciation of learning environment affordances should go beyond what school environments might offer as action possibilities to teachers and students, to encompass the more holistic context within which they might understand (perceive) how they can use the environment for various pedagogical activities.

Figure 86 (below) represents a holistic model for learning environment affordances, which encompasses the social-cultural context, or form of life of a school. It shows that affordances result from the relationship between environment (space, object and people) and user (teachers and students) enabling action possibilities for teaching and learning. It also indicates that user's abilities and intentions are a critical component to enable users to

perceive the action possibilities offered by the environment. Critically, these relationships are situated within an overarching sphere reflecting the socio-cultural context (or form of life).

Figure 86

Learning environment affordances as understood within the socio-cultural context (form of life) of a school

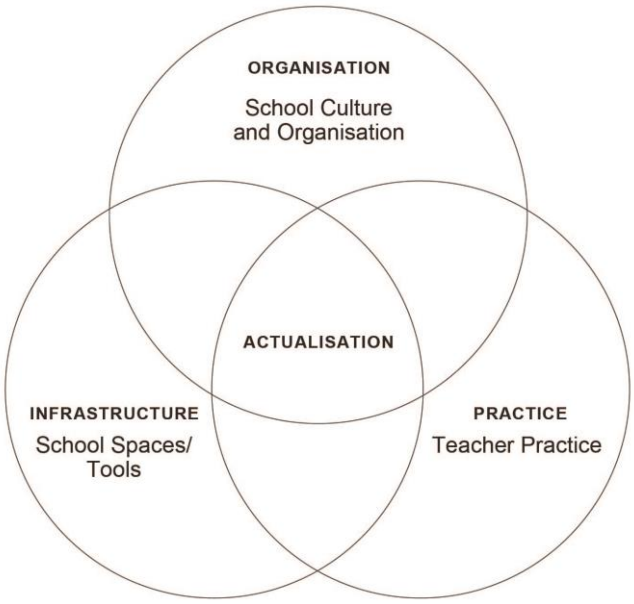


Lindberg and Lyytinen's (2013) affordance ecology model, which identifies organisation, infrastructure and practice as high level domains, provides a useful framework to consider the nature of affordance actualisation within educational contexts. These three interrelated spheres, as shown in Figure 87 (below), may be considered to relate to the school physical environment (infrastructure), a school's organisation and culture (organisation), and teacher practice (practice).

It recognises that actualisation of the affordances of ILEs requires more than just the provision of new school spaces. Overarching cultural and organisational structures also need to be taken into account to create conditions for teachers to be able to adapt their pedagogical practices to take advantage of ILEs. The infrastructure sphere relates not just to the physical context of school spaces, but also to tools that might be employed to help teachers in perceiving and utilising affordances. Tools developed as part of this research project reveal ways in which teachers can be supported to actualise ILE affordances.

Figure 87

Learning environment affordance ecology framework.



Note: *Adapted from Lindberg and Lytinnen (2013)***.**

As revealed by this research, a school's organisation and culture contributes to its socio-cultural context, or 'form of life', which may in turn influence individuals' ability to actualise affordances within school spaces. This research demonstrated that schools' conventions can enable or constrain an individual teachers' abilities to use their environment. Additionally, learning in the form of teacher professional development or tools to support affordance actualisation was also found to enhance teachers' abilities in their understanding of the potential of space to support teaching and learning activities and behaviours.

Strategies for supporting actualisation of ILE affordances

Chapters 5 and 6 discussed a range of strategies that were found to help teachers actualise the affordances of ILEs. These were identified through the two studies undertaken and collectively represented in

Figure 83 (see Chapter 6), using Lindberg and Lyytinen's (2013) ecological model as a framework to highlight the interrelated nature of organisation, practice and infrastructure in the realisation of affordances.

At an organisational level, a number of matters were identified as critical to giving teachers the agency to explore new practices within new spaces. These included:

- Having clear school and leadership values around ILEs, signifying to teachers a sense of permission to trial new practices within them.
- Timetables that allowed teachers the time and space to plan lessons together.
- Participating as part of a community of practice, enabling collective reflection on new pedagogical experiences within new spaces.

These aspects fostered a culture of trust that enabled teachers to gain confidence to evolve their practices.

At a practice level, professional learning experiences, tailored around the use of ILEs were found to help teachers learn more about the pedagogical benefits or constraints of the physical environment, and how they might navigate these. Experiences reported from this research included:

- Mentoring programs pairing experienced and early-stage teachers together to co-teach in shared spaces.
- Trialling and testing new pedagogical practices including team teaching.
- Opportunities for teachers to observe and learn from each other's practice.

It was also found that when teachers took the time to speak to their students about their learning experiences in spaces with a wider variety of settings than traditional classrooms, it greatly influenced their understandings of the benefits of ILEs. This helped teachers understand the potential of space as a resource for teaching and learning and motivated them around the use of these spaces.

At an infrastructure level, strategies that supported the actualisation of affordances within ILEs related spatial factors as well as initiatives or resources to enhance understandings of space. Beneficial spatial factors identified through this research included:

- Visual cues, through the use of environmental graphics, diagrams and inclusion of people into floor plan drawings can help make affordances explicit for users.
- Transparency, enabling more visibility to the pedagogical practices taking place within ILEs, increasing broad awareness of the affordances of new spaces.
- Prototyping spatial settings, enabling teachers to trial, test and embed new practices.

Initiatives and resources found to raise awareness of space use included:

- Excursions to innovative environments, including contemporary workplaces and other educational contexts, which exposed teachers to innovative practices within innovative spaces.
- Sharing research around ILEs, which helped bolster knowledge around the benefits of these types of spaces.
- Developing shared language and protocols around the use of new spaces, enabling the development of collective understandings of opportunities and expectations of ILEs.

Aspects relating to both leadership values and resources such as research on ILEs also have potential to influence the wider school community, including parents, on the benefits of new practices and spaces. Parents that supported innovative pedagogical approaches were recognised by participants of this research as an enabler for them to engage with new pedagogical practices.

Lindberg and Lyytinen's (2013) affordance ecology model highlights that the development of new spaces should not be viewed as a silo. The findings from this study indicate that rather than direct human-environment relationships which suggest that "spaces are themselves agents for change" (Joint Information Systems Committee (JISC) Development Group, 2006, p. 30), that broader socio-cultural factors relating to school organisational structures and teaching practice need to be taken into consideration.

In addition, recognising the interrelated nature of these spheres the study reveals that to develop successful ILEs, where teaching practice is in synch with the affordances being offered, requires both architects and educators to better understand each other's professional perspectives. If architects had deeper understandings of pedagogy, they would be better equipped to design affordances for learning. And if educators were more spatially competent (Lackney, 2008; Leighton & Byers, 2020), this would enable them to bridge their pedagogical knowledge and experiences with the physical and digital environment.

To ensure the success of new buildings, architects should consider ways in which they might support educators to transition to new ILEs. This could include ensuring that educators are involved in design processes, exposing them to potential affordances in advance of delivery of new learning spaces. It could also involve the development and implementation of prototype spaces found from this research to greatly enhance teacher's abilities to trial and

test new practices. In addition, architects could find ways (through the physical environment or in developing resources to support use) for affordances to be made more explicit to users.

Tools for supporting actualisation of ILE affordances by teachers

In keeping with the wider objectives of the ILETC ARC Linkage project, the strategies identified above informed the development of tools to support teachers to actualise the affordances of ILEs. It was recognised that all of the strategies identified were unlikely to be captured within a single tool, however through the exercises engaged with in the Study 2, a series of potential tools emerged.

Some, such as the *Avatar* and *Topography* (Chapter 6), were designed to prime participants to access and share their insights into the relationships between space and practice, creating conditions for subsequent discussions. These tools helped teachers think metaphorically in relation to their practice and beliefs. They also helped them discuss the aspirations and challenges they anticipated as a result of inhabiting new ILE spaces. Other tools, such as the *Field Guide*, were aimed at helping teachers to observe (perceive) how spaces influenced activities and behaviours. The *Field Guide* was found to enhance teachers' spatial competency (Lackney, 2008; Leighton & Byers, 2020) and aided their ability to perceive affordances for learning.

The tool *MakingSPACE*: *Strategies and Protocols to Activate Collaborative Environments*, drew teachers together to actively envisage future co-inhabitation of ILE spaces. This tool combined multiple strategies which included: a) participation as part of a community of practice (Lave & Wenger, 1991; Wenger-Trayner & Wenger-Trayner, 2015); b) use of an ephemeral prototype (Osborne, 2020); and c) the development of protocols to create a common lexicon and expectations around affordances (Chapter 6). The *MakingSPACE* tool enabled teachers to position and move to-scale representations of students, teachers and furniture items on large floor plans of their future new spaces. Drawing upon earlier findings, the floor plans were printed on whiteboard paper to allow participants to write notes capturing their thinking. The impermanent nature of the paper afforded participants more freedom and fluidity to express their ideas.

The practical application of this tool supported teachers to better visualise their future spaces and raised their awareness of the activities and behaviours that might take place within them. Seeing spaces 'inhabited' with teachers and students gave teachers a much better understanding of the likely proximity of others, and the different contexts they would need to

consider when sharing space. The discussions that took place through *Making:SPACE* helped teachers 'see' others' perspectives of space and agree on the types of 'rules' they would need to implement to be able to work together within them. Using the tool 'brought everyone closer together' in recognising the potential affordances of their future buildings and the protocols they would need to effectively actualise them. Issues discussed, such as recognition of the need for more visibility between spaces, raised consciousness about potential design adaptations required to improve the ability for teaching and learning.

The practical nature of *MakingSPACE* made it easy for participants to apply to their immediate contexts. More metaphorical priming tools were also important to help participants reflect on their own understandings of space. Whilst the researchers (Dion Tuckwell and I) felt that the priming tools were critical to achieving constructive outcomes from *MakingSPACE*, the amount of priming required was unable to be determined within the timeframes available. It is intended that beyond this PhD project, tools will be further trialled and refined with other groups of teachers in other schools.

Contributions to research

Heft (1981, 2010) noted that affordance theory has been less present in architectural discourse. Even earlier, Gibson (1979) noted that whilst architects and designers recognised the properties of building materials, they lacked a theory of affordances to encompass this knowledge into a system. This study has extended the concept of affordances from its origins in psychology into architecture, and more specifically into learning environments. By doing so, it offers a more holistic understanding in which to situate the materiality of the built environment, within learning environments.

Exploring affordances through an architectural lens has also extended understandings of the concept more broadly. Translating Lindberg and Lyytinen's (2013) relatively little know affordance ecology model from technology to the field of learning environments, has revealed convergence with the thinking of more well-recognised authors in psychology, anthropology and HCI including Costall (1995, 2012); Heft (1981, 1983, 1988, 1989, 2003, 2007, 2010); Ingold (2008); Norman (1988, 1999, 2013) and Rietveld and Kiverstein (2014), who highlight the influence of cultural contexts in relation to affordances.

This research builds on Heft's (1988) work, which developed a taxonomy of affordances for children's environments and applies this to the field of learning environments. Although there have been many studies on learning spaces, few relate

environmental qualities specifically to pedagogical activities associated with deep learning agendas. The taxonomies developed through this research reveal that a wider range of affordances exist within ILE spaces than in traditional learning environments. They also show a specificity between qualities of space and pedagogical approaches associated with deep learning. These taxonomies provide a useful foundation to support more nuanced understandings around the design and use of ILEs.

The research findings also align with a limited number studies that highlight distinctions between architects and users perceptions of space (Julean, 2016; Koutamanis, 2006; Shemesh et al., 2015; Sporrel et al., 2017). The use of the affordance-based language for learning environments developed through this study supports the correlation of designers' and users' perceptions of the functionality of space. As Koutamanis (2006) notes, this may promote better opportunities for design innovation, rather than "falling back to stereotypical solutions" (p. 357).

The research addresses gaps in the literature around use of space and methodologies to help teachers shift practice to enable innovative pedagogies in new spaces. It offers insights into teachers experiences within learning spaces, and strategies towards transitioning into and effectively actualising the affordances of ILEs. Appropriating Lindberg and Lyytinen's (2013) affordance ecology model to a school context provides a clear and comprehensive framework in which to understand an array of approaches that would enhance the likelihood of the actualisation of ILE affordances.

Finally, the unique interdisciplinary PAR/co-design methodology utilised as part of this study offers novel insights into the benefits of cross-disciplinary collaborative research as a vehicle to empower teachers in investigating their own practice change. The PAR framework offered a clear and coherent structure for the research process, whilst co-design provided participant/researchers the tools to support them to not just reflect deeply and think through the nuances of their experiences, but also enabled them a 'safe' way to share these with each other. In combination, the PAR/co-design methodology demonstrated the ability to impart teachers with the agency to change practices and to access richer and deeper data from the process.

Implications for practice

Significant amounts of time and money are being invested in the development of new learning spaces—particularly in Australia and New Zealand. In the context of ILEs, where

spaces and practices deviate from traditional classroom settings, it can be challenging to ensure efficient and effective design processes when there are differing understandings of space and learning. In the design of ILEs when affordances are perceived by designers, but not recognised by users in practice, this can result in a wasted investment (French et al., 2019). Alternatively, if educators perceive possibilities for space that could enhance their practice, yet these aren't included in design, this suggests misalignment in vision between the two professions and lost opportunity.

The taxonomies of learning environment affordances emerging from this research offer a starting point for discussion for any school design project. They offer insights toward the distinction between a form-based or function-based lexicon and the myriad ways teaching and learning action possibilities can be supported by the built form.

They also show affordances recognised by educators, yet not perceived by architects. These include the floor surface for collaboration, environmental graphics to signify potential learning activities, multiple whiteboard surfaces for student use and concave-shaped tables for enhanced collaboration. Insights such as these may inform decisions made in the process of designing new schools.

Whilst there is increasing interest in ILEs, a lack of research and evidence can also lead to a level of scepticism by those unfamiliar with their rationale. The findings discussed above provide a common foundation for both architects and educators to discuss and assess whether ILE space designs afford the pedagogical opportunities aspired to by clients/schools.

Implications for architects

An affordance-based approach to the development of school spaces can support greater likelihood of a successful outcome. Findings from this study have informed the development of an affordance-based approach to the design and delivery of new school learning spaces. This is captured in Figure 88. Three key stages of a project from developing the vision, through to delivery and realisation are shown. These stages typically begin with briefing and concept design, and then continue through into construction and occupancy.

The diagram shows how the traditional architectural approach can be aligned with an affordance-based approach supporting higher likelihood of an effective and efficient transition to ILEs. It also indicates potential issues when these steps are not employed. The two vertical dotted lines show different paths towards actualisation. Model A, resulting in more effective transition, begins the process of supporting teachers to perceive affordances at

briefing phases of a project. This indicates that they are better equipped to utilise affordances and evolve their understandings upon occupancy. Model B shows a process in which educators are not involved in the design process and introduced to the affordances of a new building only at occupancy. This model results in less effective and efficient transition.

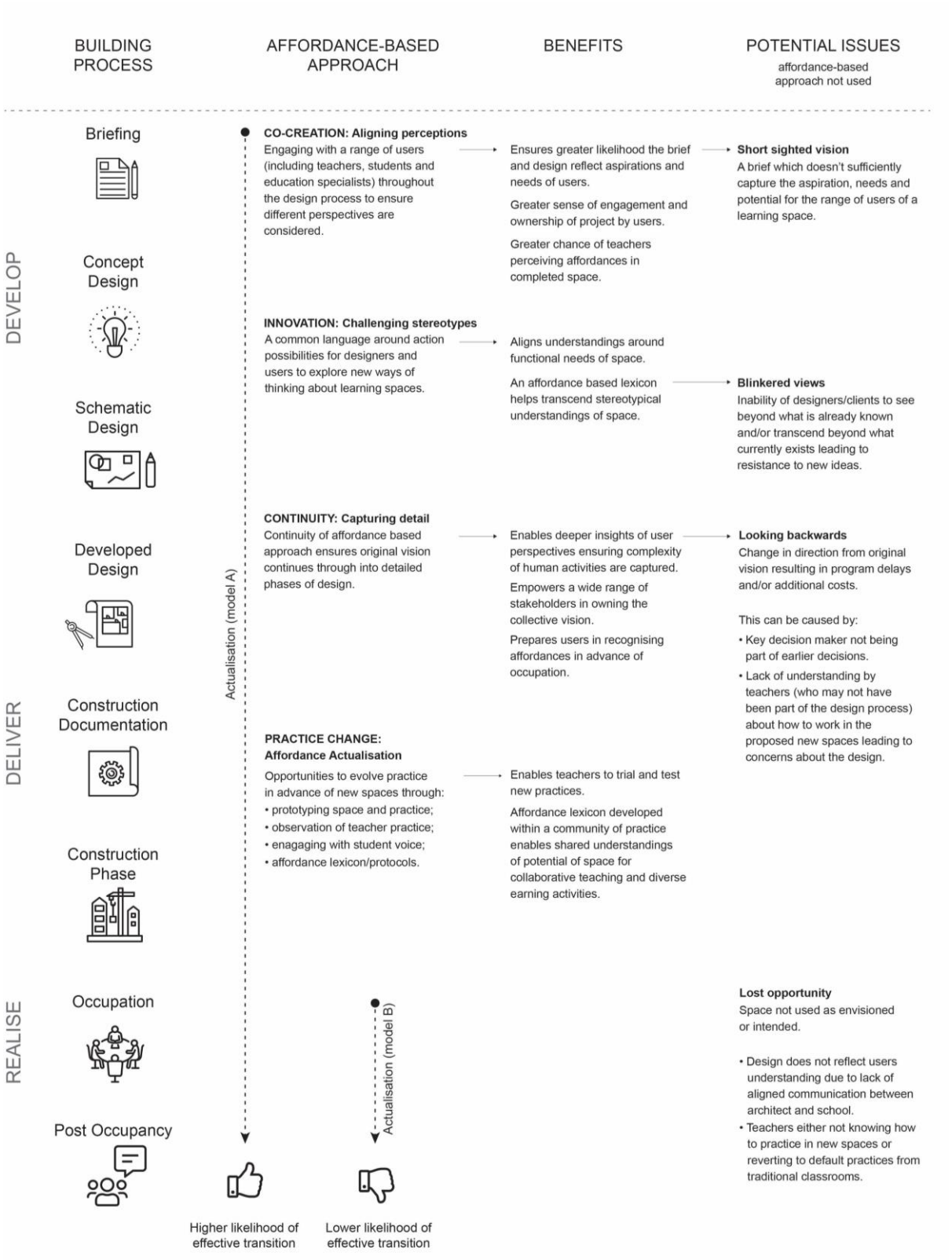
An affordance-based approach recognises that different professions and people will have varying views in relation to the requirements of school spaces and highlights the need for multiple perspectives to be taken into account in the design process. It suggests a co-creative design approach, with multiple stakeholders, which begins from briefing and continues through into detailed design phases. Processes which engage with a diverse range of users, including teachers and students, increase the likelihood of alignment of perceptions between stakeholders and for design outcomes to reflect their intentions.

It is critical for the ongoing involvement of multiple stakeholders as designs evolve, to build on established visions and to pick up on more detailed requirements of new learning spaces. Without this continuity of stakeholder/user involvement, issues may arise relating to changes in direction from an original vision. Furthermore, including users in the design process also introduces teachers to concepts around space and practice, helping them perceive potential affordances, well in advance of needing to work in a new ILE learning space.

In contrast to a more form-based lexicon prevalent within architectural contexts, this study revealed the value of a common language to better align understandings around the functional needs of space. Using functional rather than form-based language not only supports an alignment of understanding around spatial requirements, but also reduces the propensity toward blinkered views of school. Form-based terms such as ‘classroom’ or ‘desk’ are likely to conjure up commonly understood views of these elements leaving little scope to evolve what they could be. However, a functional based language which describes the spatial qualities required to enable an action possibility opens up possibilities for resultant forms. This enables both a precision around the intent of the form and also offers opportunities for creative interpretation and innovation. For example, a firm horizontal surface that’s sittable might take the form of a chair, however it could also be an ottoman, a large step, a ledge or a bench. As traditional understandings of educational practices and spaces shift, an affordance-based language is particularly relevant to enabling the evolution of stereotypical understandings of space and use.

Figure 88

Actualising the affordances of ILEs within the architectural design process



The transition to ILEs can be supported by a range of practice change strategies such as those outlined through this research. This enables opportunities for teachers to evolve their practice in advance of occupying new spaces, better preparing them for the change. Whilst this aspect is shown aligning with construction documentation in Figure 88, it could even begin earlier depending on the context of each school. Due to the iterative nature of testing, trialling and embedding new practices, time is required to engage with the process of practice change.

This study found that prototyping can aid in this process, giving teachers insights into new ways of working and empowering them in the process of change. The use of prototyping can enhance opportunities for teachers to observe and learn from each other's practice. By reflecting on these experiences as part of a community of practice of teachers can enhance more collective understandings of the occupation of new spaces. Through this process, schools can enable teachers to collectively develop shared understandings around how they might work together, better aligning understandings around the potential and expectations of future spaces.

The consequences of not engaging in affordance-based approaches to design and occupation of new ILEs can lead to spaces not used as intended. Lost opportunities may occur, due to insufficient alignment in communication between architects and school users. Furthermore, a lack of ability of teachers in using these new spaces can also lead to a misalignment between the potential of new ILEs and the practices that take place within them.

Implications for educators

As noted earlier, teachers are most familiar with the predominant traditional learning space typology (Dovey & Fisher, 2014). Given the prevalence of traditional classrooms (Imms et al., 2017), it is highly likely that educators were taught to teach within traditional classrooms, and learnt from others also most familiar with this typology. As a result, transitioning from single cell classrooms to shared ILE spaces can be a challenging shift for educators.

In the development of new ILEs, when pedagogy and space are not recognised as mutually dependent, 'building' and 'teaching practice' may remain separate activities. In this case, design decisions are likely to remain at high level, with few teachers included in the design process. Teachers may only become aware of the design of their new spaces after

designs are signed off, or even once new buildings are complete and opened. Involving educators in the design process will not only ensure higher likelihood that a design reflects users' needs, it also exposes teachers to the potential affordances of their future spaces. In this study, bringing teachers into a co-creative design process was shown to heighten teacher's awareness of space and enhance their sense of agency in using new learning environment affordances.

Bringing an affordance lens to the inhabitation of new ILE spaces was also found to aid greater understanding amongst school leadership and teachers of the 'entanglement' (Ingold, 2008) of factors that need to be considered to support actualisation. This research found that high level organisational structures need to be in place to support the practice change required to successfully use new spaces. Without clear leadership around ILE spaces, teachers may not feel that they have the permission to shift how they currently practice. In addition, allocating time for teachers to plan to practice together, and timetables that schedule them in the same space at the same time, are foundational measures needed for teachers to transition effectively from individual to more collective teaching approaches.

Within schools, an affordance-based lexicon can also support shared understandings around how spaces can be used. This could provide teachers guidance with respect to the pedagogical benefits of varying spatial qualities, highlighting expectations around the use of space, or how they can work together within them. This can also benefit students, helping them understand the protocols for learning within spaces shared by multiple teachers.

Reflections on the research process

As perception is critical to understanding the nature of learning environment affordances, it was necessary to find out how people perceived them. It also required an understanding of the process of change in order to explore ways of supporting teachers to shift their practices to actualise the affordances of new learning spaces.

A qualitative research approach allowed me to explore the perspectives of research participants in their natural settings (Ormston et al., 2013). Case studies (Yin, 2014) enabled deeper and more detailed investigation into unique contexts. Through both multiple (Study 1) and embedded (Study 2) case studies, I was able to analyse similarities and differences across different teachers' and architects' perceptions at different school sites.

Ten architects and forty-five teachers were participants in my research. This resulted in the collection of data from 20 on-site interviews, including an auto-photography

component, six focus group workshops, and an additional 50 semi-structured interviews with workshop participants. The extent and varied nature of the data collection supported triangulation, which was further enhanced through member checking (Guba & Lincoln, 1989) and triangulation (Cohen et al., 2018). Content analysis enabled data to be analysed both qualitatively and quantitatively, drawing out categories of affordances as well as how architects and teachers separately recognised these. This was followed by thematic analysis in Study 2, which enabled a more detailed and nuanced account of the data to understand teachers' experiences of change.

Empowering teachers to pick up on new affordances within ILE spaces involved supporting them to learn to shape their understandings of the relationships between pedagogy and space. The combined interdisciplinary PAR and co-design methodology provided a unique framework for participants to awaken consciousness (Crotty, 1998; Freire, 1970) of the relationship between pedagogy and the physical environment. PAR offered a clear structure to support participants to not just understand their own contexts, but also to transform them in seeking to improve the conditions in which they practiced (Kemmis et al., 2014).

The hands-on and 'designerly' co-design modes of inquiry (Sanders et al., 2012) enabled participants to access deeper insights and be able to share these with others in an engaging and safe context. Discussions with other teachers across key learning areas was a critical component in helping them shape their understandings of affordances. Through co-designed approaches, deep conversations emerged in a short space of time, fostering empathy and shared understandings around the relationship between the affordances of ILEs and teacher practice. Participants from Study 2 recognised that through this process they had shifted their understandings of space and gained agency in their practice. The iterative PAR process, in combination with the more free-form and open-ended co-design approaches, offers a new way to empower teachers through a process of change to enhance their ability to actualise the affordances of new ILE spaces.

Limitations of the study

Some methodological limitations of the research were addressed in Chapter 3. These included challenges around time availability for teachers to participate in workshops. In Study 2, whilst each workshop theme was consistent across the two schools, the time available for sessions was of shorter duration at one school than the other. This may have

limited the extent of activities and discussion that occurred. However, what took place was still of great value to the overall study. As Study 2 took place across multiple sessions, and over an extended period of time, participants varied across sessions due to illnesses and other commitments. However, there was enough consistency of participants to not adversely affect the research.

Tools developed to support teachers to actualise the affordances of ILEs were not able to be tested beyond a single iteration. With more time and resources, I would have liked to test the tools further with other teachers and other schools. I plan to do this beyond this project.

Another limitation was the difficulty in replicating the research due to the unique social settings and temporal elements, reducing transferability to other contexts. Activities in Study 2 were iteratively designed and improved upon based on outcomes from each previous workshop session. In further refining techniques and tools, it would be unlikely that they would be replicated exactly to this study. However, the strengths of the research approach, in particular the qualitative methodologies and methods employed led to deep understandings of teachers and their physical contexts, outweighing the limitations noted above.

This study centred on ILE spaces, which are intended to offer greater choice for teaching and learning activities than traditional classroom environments. As affordance recognition is determined by individual's unique contexts, which include background and experience, it is likely that a broader understanding of learning environment affordances would be gained with the inclusion of student perspectives. However, given the available time and resources, the focus of this study was solely on the educator experience.

Suggestions for further investigation

There are a number of areas emerging from this study which highlight opportunities for further research. These relate to the relationships between the environment, users and the resultant action possibilities within school settings. They include the following:

- The taxonomies of affordances resulting from the Study 1 should be seen as a starting point into investigation of learning environment affordances. They are based on perspectives of architects and educators, and do not take into account student perceptions. As ILEs are intended to enable greater student agency, further research should investigate students' perceptions of affordances.

- In Study 1, a dedicated museum learning space was identified as having the highest number of perceived affordances. This suggests that these types of spaces harbour great propensity to foster deep learning opportunities for students. There are only a few studies on the affordances of museum environments for learning (Villafranca, 2020). This is an area which could be further explored.
- This study revealed a correlation between affordances for collaborative, interdisciplinary and deep learning and characteristics of school spaces that support playful approaches to learning. With an increase in recognition of the value of play for learning at multiple stages of development (Parker & Thomsen, 2019), further studies into spatial affordances that support 'play' and 'learning' would be of value.
- Prototyping (Cleveland, 2011; Osborne, 2020) was identified as a useful strategy to help teachers become familiar with new practices. Simple ephemeral prototypes (Osborne, 2020) included rearranging furniture, or extending learning settings to co-located spaces outside of classrooms. The purpose-built prototype space at School B in Study 2 simulated an even wider range of ILE affordances, furthering opportunities for teachers to trial practices in advance of the delivery of more significant ILE buildings. However, there is very little research into prototype learning spaces and/or the prototyping of teachers practices within new or adapted spaces. This would be a valuable area for further investigation.
- The PAR/co-design approach undertaken as part of this study was an innovative methodology resulting from the collaboration of two different PhD researchers. This interdisciplinary research methodology revealed deep insights into teacher's perspectives of their relationships with space. Whilst both methodologies involve participants as researchers, combining them added to the potential of each. The co-design methodology elicited deep insights from participants within the iterative PAR framework of reflection and action. Investigations into this combination of interdisciplinary research methodologies could be explored further.

Final thoughts

Viewed solely through the lens of architectural design, the concept of affordances may seem straight forward. Some people use the term ‘affordance’ merely as an alternative for ‘design feature’. However, this would be incorrect and omits the broader holistic context in which affordances are situated, and the value that the concept offers in aligning the views of architects and users in enabling the design and inhabitation of space. Bringing together aspects of perception, abilities, intentions and the socio-cultural contexts in which spaces and people exist, broadens how architects could (and should) think about and approach the design of space. Applying an affordance-based approach to design, through design processes and use of function-based language, may give architects insights into the nuanced details of the inhabitation and use of spaces, which are difficult to see without experiencing.

This study has underscored for me the complexity of school environments and the multiple facets which need to be considered and addressed for new school spaces to fulfil the aspirations held for them. To achieve this, we need to look beyond traditional silos in which we practice as architects and educators. In this way, architects can widen their understanding of learning to ensure that they design spaces to better enable learning. Bridging this gap will also enable teachers to understand the potential of space, so that they can more effectively actualise affordances for better teaching and learning practices. Socialising the concept of affordances amongst school designers and users will support broader understandings of the complexity of school contexts and more effective processes in the development of learning spaces.

Beyond this PhD, in my professional role as an educational architect, I regularly interact with school leaders, teachers and students in designing spaces intended to support young people to acquire the deep learning skills required to help them navigate a world that is changing faster than ever before. As designers and educators, it is our duty to work together to ensure that the significant investment into new school spaces positively impacts on student learning. I hope this research highlights to architects and educators how affordance-thinking can offer a conduit toward bridging understandings around space and pedagogy, and between the latent potential of design and the actual practices that take place within schools—and ILEs in particular.

Epilogue

As a result of many years of experience designing schools and collaborating with leading educational consultants from around the world, I came into this PhD study with a solid grounding in school design. During the study, it was rewarding to collaborate with Dion Tuckwell on a novel interdisciplinary research process which guided teachers on a journey of change. It was uplifting to recognise that this process gave teachers the agency to shift their perceptions to better actualise the affordances of ILEs.

Through this process, I recognise that my perceptions have shifted too. I realise that, for architects, to be able to make considered design decisions, it is as important to concurrently address the design of physical spaces as well as people's perceptions about envisaged practices within them. By doing this, we begin to bridge the gap between potential, perception and practice.

Prior to this PhD study, I was not as conscious of the difficulties that teachers encounter when working in new ILE spaces. My increased understanding of teacher practice has given me greater empathy for teachers undertaking the challenging transition toward ILEs. As a result, my approach to school facility development has become more nuanced in relation to considerations around design, school organisational contexts and teacher practice, and the dynamic interplay between pedagogy and space.

The theory of affordances has enabled my spatial understandings to be encompassed within a system (Gibson, 1979). This has given me greater clarity about how spatial opportunities might lead to better education and the role that I, as an architect, might fulfil there — as Hertzberger (2008) suggested. I hope that through my research, others involved in school design will also gain greater awareness of the ecological context of schools and the benefits of bridging the gaps between the perceptions of architects and users, and between the potential of design and actual teaching practice. As architects and designers, this is a key path to how we can contribute to more successful school design and better education.

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Appendices

Appendix A1: Plain language statement - Designers

Appendix B Plain Lang Statement Template

PLAIN LANGUAGE STATEMENT – DESIGNERS

Innovative Learning Environments and Teacher Change

You are invited to participate in this project. We have selected you as a possible participant due to your current role as a **designer.**

The PhD research project is being conducted by **Associate Professor Wesley Imms** (Chief Investigator), Dr. Ben Cleveland (Supervisor) and **Fiona Young** (PhD student) of the **Melbourne School of Design** at The University of Melbourne. This project will form part of **Fiona Young's** thesis, and has been approved by the University of Melbourne's Human Research Ethics Committee (Program reference: 1647284; Project reference: **[1749828.1].**

The PhD research project forms part of the Innovative Learning Environments and Teacher Change (ILETC) project, an Australian Research Council (ARC) Linkage Project funded for four years from 2016-2020. Led by leading researchers, it brings together the expertise of leading researchers in education and learning environments and partner organizations in education and learning environment design and technology to investigate the use of innovative learning environments (ILEs) in schools. It responds to a broad research question, *Can altering teacher mind frames unlock the potential of innovative learning environments?*

If you agree to participate, you will be asked to contribute to this study in two ways.

First, **you will be asked to meet at a learning space at a school or museum, and provide your opinions in relation to how the learning space supports a range of learning activities. Your opinions will be captured and recorded via a mobile image capture device. This is expected to last 30 minutes.**

Second, **you may be asked to participate in a semi-structured interview to discuss the results from above, and clarify any further questions arising from the discussion. The face-to-face interview will last 30 minutes.**

We intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, within the limits of the law. In the final report, you will be referred to by a pseudonym. We will remove any references to personal information or context that might allow someone to guess your identity. However, you should note that as the number of people we seek to interview is quite small, it is quite possible that someone may identify you.

Once the report arising from this project has been completed, a brief summary of the findings will be available to you on application to the investigators, or from the Melbourne Graduate School of Education. As part of the larger ILETC project, the results will be published in academic journals, books and conferences, regional teacher workshops, a range of teacher resources and summary reports to be published on the ILETC project website (www.iletc.com.au). The data will be kept securely for five years from the completion of the larger ILETC project (including publication and public release), and will be destroyed after this time.

Please be advised that your participation in this study is completely voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice.

If you would like to participate, please indicate that you have read and understood this information by signing the attached consent form and returning it. The investigators will contact you to arrange mutually convenient times to **attend a school or museum learning space observation, or participate in an interview.**

Should you require further information, or have any concerns about the project, please do not hesitate to contact: **Associate Professor Wesley Imms (telephone number +61 3 8344 8783, w.imms@unimelb.edu.au), Dr. Ben Cleveland (telephone number +61 3 9035 3757, benjamin.cleveland@unimelb.edu.au)** and **Fiona Young (telephone +61 4 2271 4226, fionay@student.unimelb.edu.au).** If you have any queries about the ILETC project, please contact its Project Manager, Joann Cattlin, (telephone number: +613 9035 8694, joann.cattlin@unimelb.edu.au) Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

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Appendix A2: Plain language statement – Phase 1 teachers

Appendix A1 Plain Lang Statement Template

PLAIN LANGUAGE STATEMENT – PHASE 1 TEACHERS

Innovative Learning Environments and Teacher Change

You are invited to participate in this project. We have selected you as a possible participant due to your current role as a **teacher.**

The PhD research project is being conducted by **Associate Professor Wesley Imms** (Chief Investigator), Dr. Ben Cleveland (Supervisor) and **Fiona Young** (PhD student) of the **Melbourne School of Design** at The University of Melbourne. This project will form part of **Fiona Young's** thesis, and has been approved by the University of Melbourne's Human Research Ethics Committee (Program reference: 1647284; Project reference: **[1749828.1].**

The PhD research project forms part of the Innovative Learning Environments and Teacher Change (ILETC) project, an Australian Research Council (ARC) Linkage Project funded for four years from 2016-2020. Led by leading researchers, it brings together the expertise of leading researchers in education and learning environments and partner organizations in education and learning environment design and technology to investigate the use of innovative learning environments (ILEs) in schools. It responds to a broad research question, *Can altering teacher mind frames unlock the potential of innovative learning environments?*

If you agree to participate, you will be asked to contribute to this study in two, and possibly three ways.

First, **you will be asked to respond to a survey about teachers' beliefs and effective teaching and learning. The survey will take a maximum of 15 minutes.**

Second, **you will be asked to meet at a learning space at your school or a museum, and provide your opinions in relation to how the learning space supports a range of learning activities. Your opinions will be captured and recorded via a mobile image capture device. This is expected to last 30 minutes.**

Third, **you may be asked to participate in a semi-structured interview to discuss the results from first and second sections above, and clarify any further questions arising from the discussion. The face-to-face interview will last 30 minutes.**

We intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, within the limits of the law. In the final report, you will be referred to by a pseudonym. We will remove any references to personal information or context that might allow someone to guess your identity. However, you should note that as the number of people we seek to interview is quite small, it is quite possible that someone may identify you.

Once the report arising from this project has been completed, a brief summary of the findings will be available to you on application to the investigators, or from the Melbourne Graduate School of Education. As part of the larger ILETC project, the results will be published in academic journals, books and conferences, regional teacher workshops, a range of teacher resources and summary reports to be published on the ILETC project website (www.iletc.com.au). The data will be kept securely for five years from the completion of the larger ILETC project (including publication and public release), and will be destroyed after this time.

Please be advised that your participation in this study is completely voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice.

If you would like to participate, please indicate that you have read and understood this information by signing the attached consent form and returning it. The investigators will contact you to arrange mutually convenient times to **undertake a survey, attend a school or museum learning space observation, or participate in an interview or PAR workshops.**

Should you require further information, or have any concerns about the project, please do not hesitate to contact: **Associate Professor Wesley Imms (telephone number +61 3 8344 8783, w.imms@unimelb.edu.au), Dr. Ben Cleveland (telephone number +61 3 9035 3757, benjamin.cleveland@unimelb.edu.au)** and **Fiona Young (telephone +61 4 2271 4226, fionay@student.unimelb.edu.au).** If you have any queries about the ILETC project, please contact its Project Manager, Joann Cattlin, (telephone number: +613 9035 8694, joann.cattlin@unimelb.edu.au) Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

HREC Program: 1647284; HREC Project: 1749828.1; **Date:** 6/11/17; **Version:** 1.0

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Appendix A3: Plain language statement – Phase 2 teachers

Appendix A2 Plain Lang Statement Template

PLAIN LANGUAGE STATEMENT – PHASE 2 TEACHERS

Innovative Learning Environments and Teacher Change

You are invited to participate in this project. We have selected you as a possible participant due to your current role as a **teacher.**

The PhD research project is being conducted by **Associate Professor Wesley Imms** (Chief Investigator), Dr. Ben Cleveland (Supervisor) and **Fiona Young** (PhD student) of the **Melbourne School of Design** at The University of Melbourne. This project will form part of **Fiona Young's** thesis, and has been approved by the University of Melbourne's Human Research Ethics Committee (Program reference: 1647284; Project reference: **[1749828.1].**

The PhD research project forms part of the Innovative Learning Environments and Teacher Change (ILETC) project, an Australian Research Council (ARC) Linkage Project funded for four years from 2016-2020. Led by leading researchers, it brings together the expertise of leading researchers in education and learning environments and partner organizations in education and learning environment design and technology to investigate the use of innovative learning environments (ILEs) in schools. It responds to a broad research question, *Can altering teacher mind frames unlock the potential of innovative learning environments?*

If you agree to participate, you will be asked to contribute to this study in two ways.

First, **you will be asked to respond to a survey about teachers' beliefs and effective teaching and learning. The survey will take a maximum of 15 minutes.**

Second, **you will be asked to participate in a Participatory Action Research (PAR) study. This will involve attending no more than six workshops over a six-month period which will be facilitated by the researcher or her assistant. Each workshop will last 60 minutes, and involve a combination of discussion, observation, interviews, and practical activities around teaching and learning within ILEs. It is expected that in between workshops, teachers will continue to develop thinking around the workshop themes. It is important to note that the workshops will be focused on your activities and that this research will not gather data from students present during the sessions.**

We intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, within the limits of the law. In the final report, you will be referred to by a pseudonym. We will remove any references to personal information or context that might allow someone to guess your identity. However, you should note that as the number of people we seek to interview is quite small, it is quite possible that someone may identify you.

Once the report arising from this project has been completed, a brief summary of the findings will be available to you on application to the investigators, or from the Melbourne Graduate School of Education. As part of the larger ILETC project, the results will be published in academic journals, books and conferences, regional teacher workshops, a range of teacher resources and summary reports to be published on the ILETC project website (www.iletc.com.au). The data will be kept securely for five years from the completion of the larger ILETC project (including publication and public release), and will be destroyed after this time.

Please be advised that your participation in this study is completely voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice.

If you would like to participate, please indicate that you have read and understood this information by signing the attached consent form and returning it. The investigators will contact you to arrange mutually convenient times to **undertake a survey, attend a school or museum learning space observation, or participate in an interview or PAR workshops.**

Should you require further information, or have any concerns about the project, please do not hesitate to contact: **Associate Professor Wesley Imms (telephone number +61 3 8344 8783, w.imms@unimelb.edu.au), Dr. Ben Cleveland (telephone number +61 3 9035 3757, benjamin.cleveland@unimelb.edu.au)** and **Fiona Young (telephone +61 4 2271 4226, fionay@student.unimelb.edu.au).** If you have any queries about the ILETC project, please contact its Project Manager, Joann Cattlin, (telephone number: +613 9035 8694, joann.cattlin@unimelb.edu.au) Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

HREC Program: 1647284; HREC Project: 1749828.1; **Date:** 13/07/18; **Version:** 1.0

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Appendix B1: Consent form - Designers

Appendix D Consent Form – Designers

Melbourne Graduate School of Education

Consent form for persons participating in a research project

Project title	**Innovative Learning Environments and Teacher Change**
Program reference	**1647284.1**
Project reference	**1749828.1**

Name of participant:

Name of investigators: **Fiona Young (student), Associate Professor Wesley Imms**, **Dr. Ben Cleveland and Dr. Kenn Fisher** (supervisors), **Dr. Marian Mahat** (ILETC Research Manager)

1. I consent to participate in this project. The details of the project have been explained to me, and I have been given a written Plain Language Statement to keep.

2. I understand that after I sign and return this consent form it will be retained by the investigators.

3. I understand that my participation may involve **attendance at a learning space observation session**, and **semi-structured interview** and I agree that the investigators may use the results as described in the Plain Language Statement.

4. I acknowledge that:

   (a) the possible effects of participating in **a learning space observation session**, and **semi-structured interview** have been explained to my satisfaction.

   (b) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided.

   (c) the project is for the purpose of research.

   (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements[1]. I have also been informed that as the number of institutions and people involved is quite small, it is possible that someone may identify me.

   (e) I have been informed that any data will be stored securely beyond the completion of the larger ILETC project for five years (including publication and public release), before being destroyed after this time.

   (f) my name will be referred to by a pseudonym in any publications arising from the project;

   (g) I have been informed that a copy of the summary of project findings will be forwarded to me, should I wish to receive this.

I consent to these **learning space observations to being recorded and semi-structured interviews** being **audio-taped**	☐ Yes	☐ No
I wish to receive a copy of the summary project report on the study findings	☐ Yes	☐ No

Participant signature	**Date**

[1] It is possible for data to be subject to subpoena, freedom of information request or mandated reporting by some professions.

Appendix B2: Consent form – Teachers

Appendix C Consent Form – School Teachers

Melbourne Graduate School of Education

Consent form for persons participating in a research project

Project title	**Innovative Learning Environments and Teacher Change**
Program reference	**1647284.1**
Project reference	**1749828.1**

Name of participant:

Name of investigators: **Fiona Young (student), Associate Professor Wesley Imms**, **Dr. Ben Cleveland and Dr. Kenn Fisher** (supervisors), **Dr. Marian Mahat** (ILETC Research Manager)

1. I consent to participate in this project. The details of the project have been explained to me, and I have been given a written Plain Language Statement to keep.

2. I understand that after I sign and return this consent form it will be retained by the investigators.

3. I understand that my participation may involve **filling in a survey, attendance at a learning space observation session**, and **semi-structured interview, or participation as part of a Participatory Action Research project** and I agree that the investigators may use the results as described in the Plain Language Statement.

4. I acknowledge that:

   (a) the possible effects of participating in **a survey, attendance at a learning space observation session**, and **semi-structured interview, or participation as part of a Participatory Action Research project** have been explained to my satisfaction.

   (b) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided.

   (c) the project is for the purpose of research.

   (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements[1]. I have also been informed that as the number of institutions and people involved is quite small, it is possible that someone may identify me.

   (e) I have been informed that any data will be stored securely beyond the completion of the larger ILETC project for five years (including publication and public release), before being destroyed after this time.

   (f) my name will be referred to by a pseudonym in any publications arising from the project;

   (g) I have been informed that a copy of the summary of project findings will be forwarded to me, should I wish to receive this.

I consent to these **learning space observations to being recorded and semi-structured interviews** being **audio-taped**	☐ Yes	☐ No
I wish to receive a copy of the summary project report on the study findings	☐ Yes	☐ No

Participant signature	**Date**

[1] It is possible for data to be subject to subpoena, freedom of information request or mandated reporting by some professions.

Appendix C: List of participants

Study 1 participants

Site		Teacher	No. of years experience	Architect
1	Traditional Primary school	Teacher 1	3	
		Teacher 2	6	
		Teacher 3	8	
		Teacher 4	20	
				Architect A
				Architect B
2	Traditional Secondary school	Teacher 5	1	
		Teacher 6	3	
		Teacher 7	10	
		Teacher 8	20	
				Architect C
				Architect D
3	ILE Primary school	Teacher 9	2	
		Teacher 10	4	
		Teacher 11	8	
		Teacher 12	14	
				Architect E
				Architect F
4	ILE Secondary school	Teacher 13	3	
		Teacher 14	6	
		Teacher 15	7	
		Teacher 16	44	
				Architect G
				Architect H
5	ILE Museum learning space	Teacher 17	1	
		Teacher 18	4	
		Teacher 19	6	
		Teacher 20	18	
				Architect I
				Architect J

Study 2 participants

School		Teacher	No. of years experience
A	Traditional Secondary School	Teacher 21	3
		Teacher 22	4
		Teacher 23	16
		Teacher 24	16
		Teacher 25	19
		Teacher 26	22
		Teacher 27	26
		Teacher 28	unknown
		Teacher 29	unknown
		Teacher 30	unknown
		Teacher 31	unknown
B	Secondary School with prototype ILE	Teacher 32	2
		Teacher 33	4
		Teacher 34	5
		Teacher 35	12
		Teacher 36	12
		Teacher 37	17
		Teacher 38	28
		Teacher 39	33
		Teacher 40	unknown
		Teacher 41	unknown
		Teacher 42	unknown
		Teacher 43	unknown
		Teacher 44	unknown
		Teacher 45	unknown

Appendix D: Process checklist for Study 1 field work

PROCESS FOR CASE STUDY FIELD WORK

1. Prior to arrival at school/site
   - ☐ Principal (or other) has been sent Plain Language Statement (for principal).
   - ☐ Principal (or other) has sent back endorsement form.
   - ☐ Teachers have been sent Plain Language Statement via principal or other contact.
   - ☐ Architects have been sent Plain Language Statement.

2. Tools for Sampling
   - ☐ Voice recorder
   - ☐ iPad
   - ☐ Additional Plain Language Statement and Consent Forms for teachers
   - ☐ Additional Plain Language Statement and Consent Forms for architects
   - ☐ Set of Plain Language Statement for Principal and endorsement form.

3. On the day
   - ☐ Arrive at least 30min in advance to sign in – go to space.
   - ☐ Get signed endorsement form from school/site (if not received prior)
   - ☐ Get signed consent forms from teachers or architects (if not received prior)
   - ☐ Check procedure for getting participants to space (especially the architects)
   - ☐ Have contact form for participant to fill in whilst waiting
   - ☐ Bring on-site interview question templates (educator/architects)

4. After each session
   - ☐ Review responses for each participant
   - ☐ List the number of different ‘affordances’ seen for each participant

5. Semi-structured interview
   - ☐ Bring on-site interview question templates (educator/architects)
   - ☐ Bring list of ‘affordances’ noted by each participant

Appendix E: Study 2 Authorship of workshop design process

As noted in the research design, Study 2 comprised six workshops which were co-designed and facilitated with Dion Tuckwell from Monash University. My focus at this stage of the research was to investigate how to support teachers to actualise learning environment affordances using the Participatory Action Research (PAR) methodology. Dion's research focusses on transdisciplinary design and as part of this study explored how engaging a practice-based approach contributed to the overarching aims of teacher change. General principles around the partnership involved Dion designing the workshops based on an understanding of the outcomes I was seeking from the overall process and individual sessions. However, like any good design process this required dialogue between 'designer' and 'client' in order to develop the final design. The table below indicates the attribution of our various inputs to the workshop session.

Workshop	**Fiona Young**	**Dion Tuckwell**
Methodological focus	Participatory Action Research (PAR)	Co-design
Briefing	Study 1 outcomes informed the themes and materials developed for workshops. This included the taxonomy of affordances.	
Workshop 1	• Provision of taxonomy of affordances • Co-facilitation	• Design of materials used and agenda for workshop • Primary facilitation
Workshop 2	• Synthesis of data from semi-structured interviews as basis for Workshop 2 • Workshop design and facilitation	
Workshop 3	• Synthesis of Workshop 2 to inform design of Workshop 3 • Co-facilitation	• Design of materials used and agenda for workshop • Primary facilitation
Workshop 4	• Co-facilitation	• Design of materials used and agenda for workshop • Primary facilitation
Workshop 5	• Synthesis of key themes from Workshops 1 to 4 in	• Design of materials used and agenda for workshop

	relation to perceiving and utilising affordances • Co-facilitation	• Primary facilitation
Workshop 6	• Synthesis of key themes from Workshops 1 to 4 in relation to perceiving and utilising affordances • Co-design of materials used for workshop • Co-facilitation	• Co-design of materials used for workshop • Development of workshop agenda • Primary facilitation

Appendix F: Study 2 - Phase 2 Workshop handout

Thank you for being a participant as part of phase two of the ***Innovative Learning Environments and Teacher Change*** **(ILETC)** project. The aim of this Participatory Action Research (PAR) project is to explore the process of change to support teachers' transition to new learning spaces. Over the next four months we look forward to working with you to better understand how change occurs, and what the constraints and enablers of change are. At the culmination of this process we hope to clarify a range of strategies and develop tools to support teachers to enhance their use of Innovative Learning Environments (ILEs). These will then be tested with a wider cross-section of schools in phase three of the project.

Project Methodology

The PAR process will comprise four workshops and two semi-structured interviews. As a participatory process, based on discussion and reflections emerging from the workshops we will collectively determine actions to be trialled and tested between sessions 2 and 4. The design of the workshops will be based on a co-design approach which actively involves all stakeholders in the design process to ensure the designed outcome meets their particular needs. The use of co-design strategies provides a pathway for participants to reflect on their own practices and gain deeper insights.

How can we prepare ourselves to effectively use our new learning spaces?

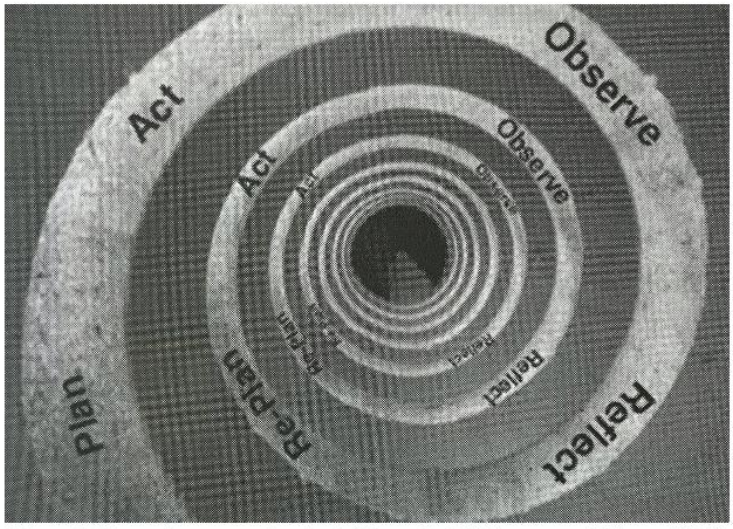


Figure 1. The action research spiral. (Kemmis, McTaggart and Nixon, 2014)

Session 1: Reconnaissance – How do things work here?
- 2.45pm, Tuesday 22 August

Semi-structured interview
- Date tbc

Session 2: Planning + determining observation method
- 2.45pm, Tuesday 18 September

Session 3: Reflection and Review
- 2.45pm, Tuesday 23 October

Session 4: Reflection
- 2.45pm, Tuesday 20 November

Semi-structured interview
- Date tbc

We look forward to working with you!
Fiona Young (The University of Melbourne) & Dion Tuckwell (Monash University)

Appendix G: Study 1 Auto-photography analysis

			Educator	Educator	Educator	Educator	Architect	Architect	Educator	Educator	Educator	Educator	Architect	Architect	Educator	Educator	Educator	Educator	Architect	Architect	Educator	Educator	Educator	Educator	Educator	Educator	Architect	Architect	Educator	Educator	Educator	Educator	Architect	Architect
SPACE					No pics		Few pics	Few pics				No pics	No pics							No pics						Few pics								
Zone	Larger space																		1		1				1									
Zone	Spatial diversity?																		1															
Zone	Maker space																												1		1		1	1
Zone	Nook																																1	
Zone	Outside deck/terrace		1													1	1																	1
Zone	Space outside the room								1																									
Zone	Floor space		1			1																			1									
zone	Lab																				1	1				1								
zone	Wet area		1												1				1										1					
zone	teachers workspace																								1	1								
zone	storage room															1	1																	
zone	tiered space														1	1	1		1															
zone	breakout room															1			1															
zone/fitting	library/books			1												1			1															
Finishes	Circle on floor																												1	1			1	1
Fitting	Open storage		2	5											1	1	1	1											2		1	1	1	1
Fitting	Cupboard																												1					
Fitting	Glazed screen																												1	1		1		
Fitting	Sink			1																									1					
Fitting	Power in floor	mobility																				1			1									
Fitting	Display		1	6					1																								1	
Fitting	Learning protocols/notices		1	1		1																												
Fitting	Bag racks															1																		
Fitting	Retractable wall									1			1		1																			
Finishes	Mural																														1	1	1	1
Finishes	Whiteboard		1	1					1						1				1			2	1	1	1							1	
Finish/fitting	Glazed connection																																1	
IEQ	light																									1							1	
OBJECT																refers to teacher table set up																		
furniture	diversity of furniture															1	1	1	1		1	1	1	1										
furniture	Pile of cushions	moveable															1		1		1								1		1	1		
furniture	ottoman	moveable																											1					
furniture	soft hand armchair		1																															
furniture	mobile furniture generally	moveable																												1			1	
furniture	Table on Wheels	moveable																				1	1	1					2		1		1	
furniture	writeable table																	1												1				
furniture	Desks/tables		1	1		1		1	1	1	1		1																					
furniture	low storage seat														1			1	1															
furniture	Low table		1												1																			
furniture	Single table		2	1											1	1	1	1																
furniture	high tables																				1				1	1								
furniture	round table														1	2	1	1																
furniture	round blue table settings																				1			1	1	1								
furniture	Bigger table in wet area		1	1																														
furniture	mobile whiteboard	moveable																															1	
furniture	teacher desk								1																									
furniture/tech	Pivot LCD on wheels	moveable														1	1												1	1		1	1	1
joinery	Pivot Bench	moveable																											1				1	
joinery	Mobile resources	moveable																													1			
technology	Digital touch table																												1		1	1	1	1
technology	Green screen																													1			1	
technology	VR Zone																													1				
technology	LCD screen																													1	1			
technology	PCs																				1	1			1	1	1							
technology	3D printers																																1	
technology	projector/screen		1				1																											1
	Plants										1																						1	
	museum objects																															6		
			15	**18**	**0**	**3**	**1**	**1**	**5**	**2**	**2**	**0**	**2**	**0**	**9**	**12**	**10**	**6**	**9**	**0**	**7**	**7**	**4**	**10**	**7**	**1**	**15**	**8**	**8**	**12**	**18**	**8**
			38						**11**						**46**						**36**						**69**					

DIFFERENCES IN SELECTION

Architects finding less of note than educators
Educators noting open storage/resources and display
Educators noticing more about types of furniture
Good natural light

good natural light

good natural light
Educators noted storage areas and
Differences in furniture settings.

Educators more specific about furniture type
Educators noted power in floor

pile of cusions
glazed screen

GENERAL COMMENTS

can sometimes be very difficult to see what is being photographed when it's not object specific
Way less noted in traditional spaces than ILEs by both professions
Educators more specific about furniture
Educators tended to note storage more
Architects tended to take less photos

Appendix H: Study 2 - Phase 1 Workshop 1

Enablers and Constraints relative to learning principles by Mattingly (2016)

	TOTAL RESPONSES ACROSS SCHOOLS A & B		Getting frequent feedback and ways to use it are important for student learning.		Deep learning often happens when students are confused, struggle, and even fail.		Lessons should be designed to accommodate a range of learners.		Good instruction makes concepts and learning easy to grasp.		Students should be consistently challenged and held to rigorous standards.		Enduring learning requires multiple opportunities to learn something over time.		Students need to be taught how to learn effectively.		Ascertaining prior student knowledge and skills is a key to teaching success.		Deep, durable, and transferable learning is highly effortful.		Collaborative learning with lots of student talk is an effective way to learn.		Metacognition (thinking about how one thinks) is a key learning skill and mindset.		A student's sense of self-efficacy is crucial to their academic success.		Students learn best when intrinsically motivated and effective teaching strives to achieve this	
SPATIAL QUALITIES (Enabler/Constraint)	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**
A range of different settings	**12**		1		1		1					1	1		1		1				3		2				1			
Centralised storage	**1**																				1									
Digital resources	**9**	**2**	1		1		1		1				1		1		1		1			1	1				1	1		
Natural light, ventilation, air temp	**6**	**1**					1				1						1		1				1	1			1			
Other students	**9**	**12**	1				1			1	1	1			1	1		1			3	3		2			1	1		
Virtual workspace	**10**		1		1	1	1		1								1				2	1	1				2			
Seating and horizontal work surfaces	**2**	**1**					1																			1	1			
Open floor space	**6**	**1**					1			1											3		1				1			
Moveable seating and work surfaces	**11**	**1**			1		2				1					1	1		1		3						2			
Display spaces	**8**	**4**	2	1			1	1			1				1		1	1			3		2				1			
Acoustic absorption and other devices to support sound quality of space	**7**	**5**		1			1		1	1	1									1	2	1	1	1			1			
Sink and durable floor covering	**2**						1																				1			
Walls that can be opened or closed	**6**						1										1		3								1			
Writeable whiteboard wall surfaces	**15**	**1**	2		1		1		2						1	1	1				3		3				1			
Connected spaces	**7**	**3**					2	1												1	3				1	1	1			
Space for teachers to work together	**11**		2				2								1	1	1				1		3				3			
Outdoor spaces co-located to internal spaces	**4**	**1**					1					1									1				1		1			
Smaller defined areas	**13**	**2**	1		1		1		1			1	1				1		1		3	1					1			
Larger than traditional learning spaces	**8**	**8**					1		1			1	1								3	2	1				1			
Space that can be changed/used in different ways	**14**	**3**			1		2		2		1						2		1		2	1	3		1		2			
Material and colour finishes	**2**	**1**							1														1	1						

- Cells in red border indicate highest rated enabling spatial qualities
- Cells shaded in yellow indicate highest rated constraining special qualities

	TOTAL RESPONSES ACROSS SCHOOLS A & B		Getting frequent feedback and ways to use it are important for student learning.		Deep learning often happens when students are confused, struggle, and even fail.		Lessons should be designed to accommodate a range of learners.		Good instruction makes concepts and learning easy to grasp.		Students should be consistently challenged and held to rigorous standards.		Enduring learning requires multiple opportunities to learn something over time.		Students need to be taught how to learn effectively.		Ascertaining prior student knowledge and skills is a key to teaching success.		Deep, durable, and transferable learning is highly effortful.		Collaborative learning with lots of student talk is an effective way to learn.		Metacognition (thinking about how one thinks) is a key learning skill and mindset.		A student's sense of self-efficacy is crucial to their academic success.		Students learn best when intrinsically motivated and effective teaching strives to achieve this	
SPATIAL QUALITIES	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**	**E**	**C**
A range of different settings	**12**		Instant feedback which is one on one, smaller group settings etc		Space to spread out, think and reflect								Useful to run various workshops or have students working on an area of particular need at their own pace.		Can be helpful to see different styles of learning						Providing for different students learning styles Create autonomy		Linking space to learning						
Centralised storage	**1**																											
Digital resources	**9**	**2**							All for multiple ways of instructing				Useful for off-site learning at a time of personalisation		Can provide a range of strategies													
Natural light, ventilation, air temp	**6**	**1**									Students won't rise to challenges if uncomfortable								Need optimal conditions				Well-ventilated, bright room can enable clear thinking				Comfortable, inviting	
Other students	**9**	**12**	Peer feedback		Can assist, encourage, compare with others to informs others understanding				Students don't always know how to collaborate – can detract from learning		Can challenge students to rise to another's standard but also can cause anxiety, lack of confidence.				Can offer examples / also can cause social anxiety/ fear of trying something		Possible distractions				Can encourage and prevent Provide follow up potential / help weaker students have a voice Correct grouping of students Effective grouping is important		May limit time for self reflection Other students who think differently can cause comparison/ barriers				Noise, distraction	
Virtual workspace	**10**	**2**	Enable feedback to be given without face to face contact		Allows for easy deletion of work when mistakes / can be useful / focus on final product rather than process												Could use a digital tool to ascertain this outside of school hours				Shared digital space - Students may not contribute equally - reduces social skills eg. negotiation, compromise		Can offer potential to represent thinking that isn't verbal					
Seating and horizontal work surfaces	**2**	**1**																							For some students the traditional seating style enhances stress			

- School A comments in green / School B comments in black
- Cells in red border indicate highest rated enabling spatial qualities
- Cells shaded in yellow indicate highest rated constraining special qualities
- Yellow highlighted text suggests constraints

Enablers and Constraints relative to learning principles by Mattingly (2016) – continued

Open floor space	6	1				At times this can reduce focus						Access to each other to enable discussion			Greater diversity of learning spaces (links to open/closed walls)
Moveable seating and work surfaces	11	1			Flexibility		Encourage adaptability		Can provide instability						
Display spaces	8	4	Allows for feedback from students and teachers				Reinforce standards, expectations			Using displays to revisit knowledge when being tested		Represent student work Visually display expectations, instructions, goals Spaces to display keywords, ideas	Allows visualisation		Audience for the work
Acoustic absorption and other devices to support sound quality of space	7	5	Needs to be considered			Students need to be able to hear the teacher This can allow for clear communication	Enable comfortable environment for challenging				Must be considered	Sound is key Too many students, too much noise Enables discussion to work effectively for a large group	Too loud = hard to think		
Sink and durable floor covering	2														
Walls that can be opened or closed	6														
Writeable whiteboard wall surfaces	15	1	Learning is highly visible and feedback is instant (teacher walking around space)	Students can see each others work through mistakes					Can be used positively in sharing ideas and ways to learn			Note what has happened Assist discussions and thinking space	Making thinking visible – focus on the process Allows students to visually represent how they came to an understanding		Thinking becomes visible – instant feedback from peers and teachers
Connected spaces	7	3			Well thought out allows for flexibility but can be loud or sensory overload						Constraint if distractng	Split up students to work in different areas		Can help students feel good about their work or cause more stress to comparing with other students	
Space for teachers to work together	11				Allows for grouping collaboration feedback				Can see the examples from teachers				Reflection on own practice through dialogue		Teacher collaboration – sharing of effective teaching strategies Working together, collaboration builds ability

Enablers and Constraints relative to learning principles by Mattingly (2016) - continued

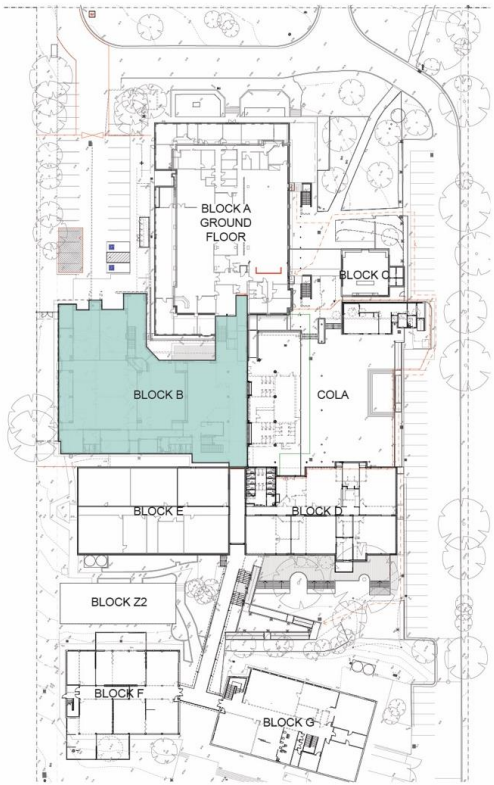
Outdoor spaces co-located to internal spaces	**4**	**1**					How students behave and react with changing learning spaces – fluctuating standards in different environments							Allows workspace choice and sense of connection to nature	
Smaller defined areas	**13**	**2**	Quiet for 1 on 1 small group	To allow safe spaces for intervention				Smaller for workshops							
Larger than traditional learning spaces	**8**	**8**						Movement, flow and multiple learning opportunities				Distractions of larger groups can take away from effective collaboration Discussion space			
Space that can be changed/used in different ways	**14**	**3**				Explicit teaching to the whole class or smaller groups Flexible spaces can allow one-o-one tutoring	Consistency through change					Students may take too long to settle with a changing space Flexible environment allows for lots of grouping options	Thinking about why we use each space – what spaces are their preference (awareness of their own learning styles) Can encourage a new approach	Flexibility to sit, stand, work in comfortable manner reduces stress and enhances self-confidence	Student choice – how they would like to learn To support teaching strategy to build intrinsic motivation
Material and colour finishes	**2**	**1**											Provide patterns / non-verbal reminders Some finishes hinder a sense of shared discussion / thinking		
					Student choice in how/where they learn					Not a lot about the environment should get in the way of ascertaining prior student knowledge and skills		Space is important to deal with and noise levels and the class environment			

- School A comments in green / School B comments in black
- Cells in red border indicate highest rated enabling spatial qualities
- Cells shaded in yellow indicate highest rated constraining special qualities
- Yellow highlighted text suggests constraints

Appendix I: School A

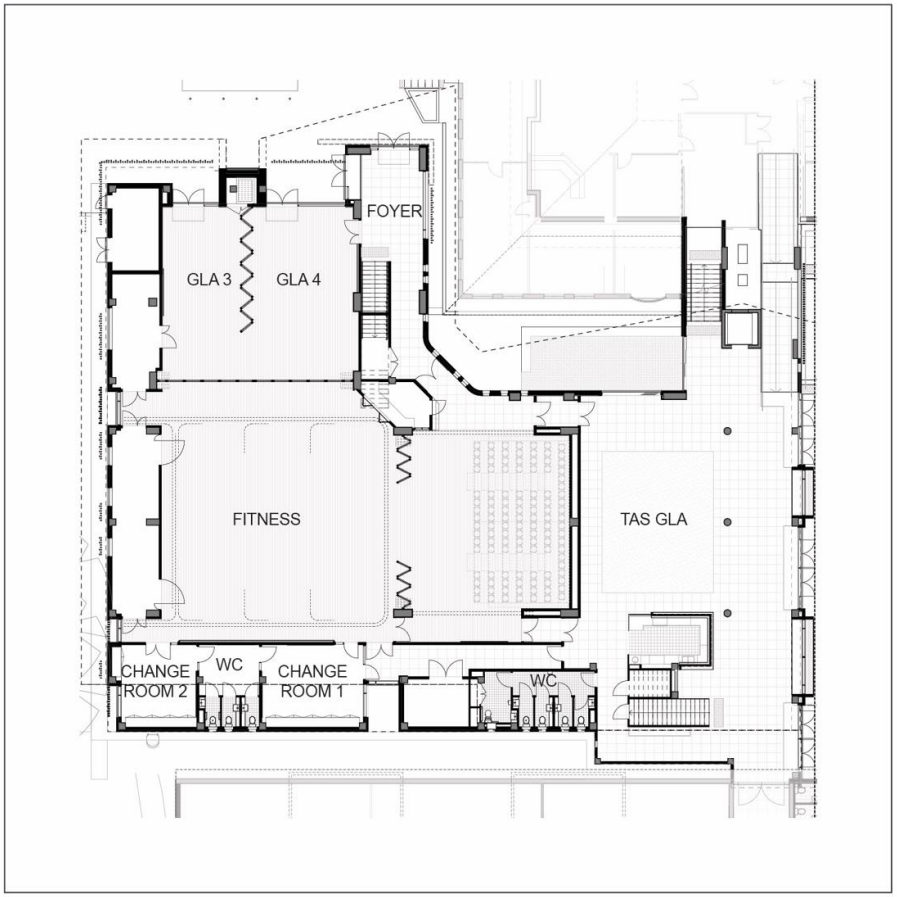
Site Context

Aerial view of existing site.
Source: https://maps.six.nsw.gov.au

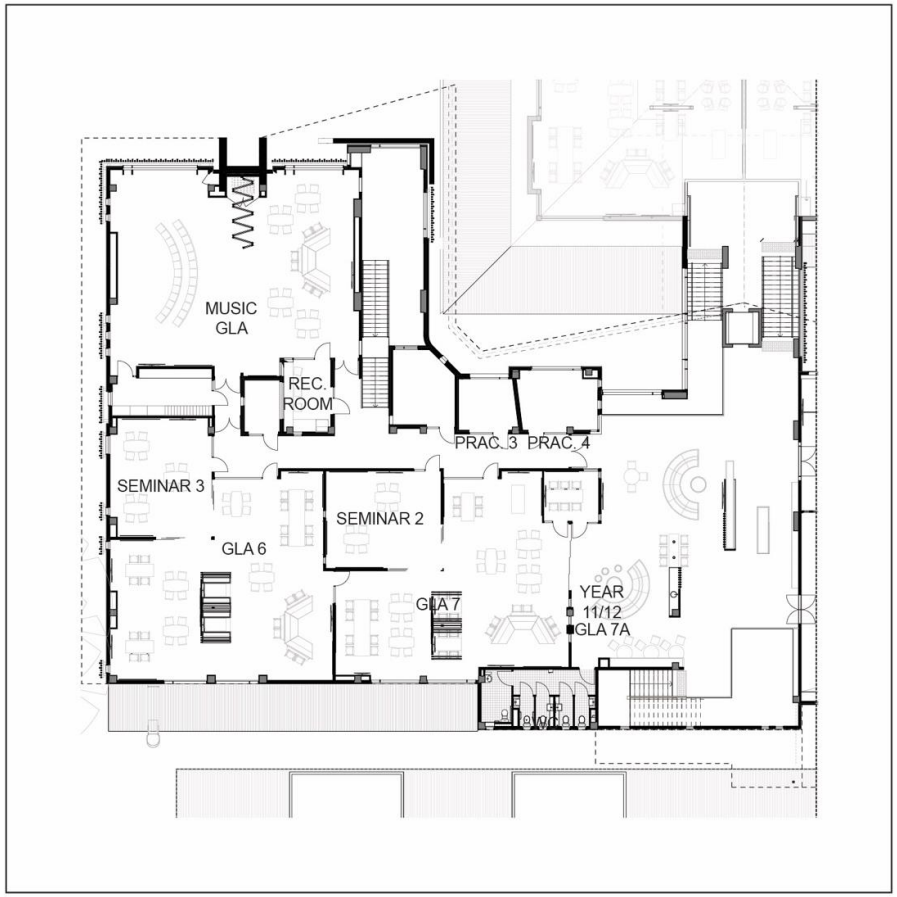


Site Plan showing Block B.
Drawing courtesy of Stanton Dahl Architects.

New ILE Building (Block B)



Proposed Ground Floor Plan.
Drawing courtesy of Stanton Dahl Architects.

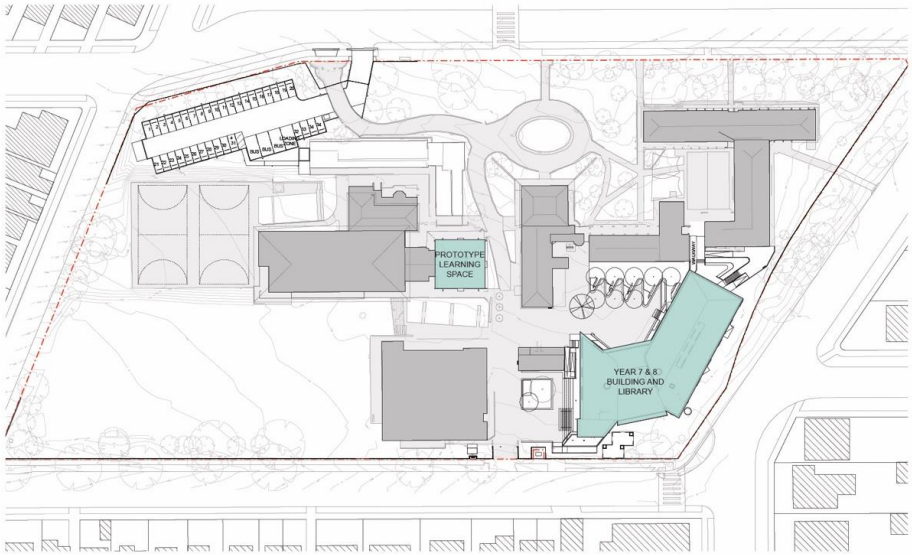


Proposed First Floor Plan.
Drawing courtesy of Stanton Dahl Architects.

Appendix J: School B

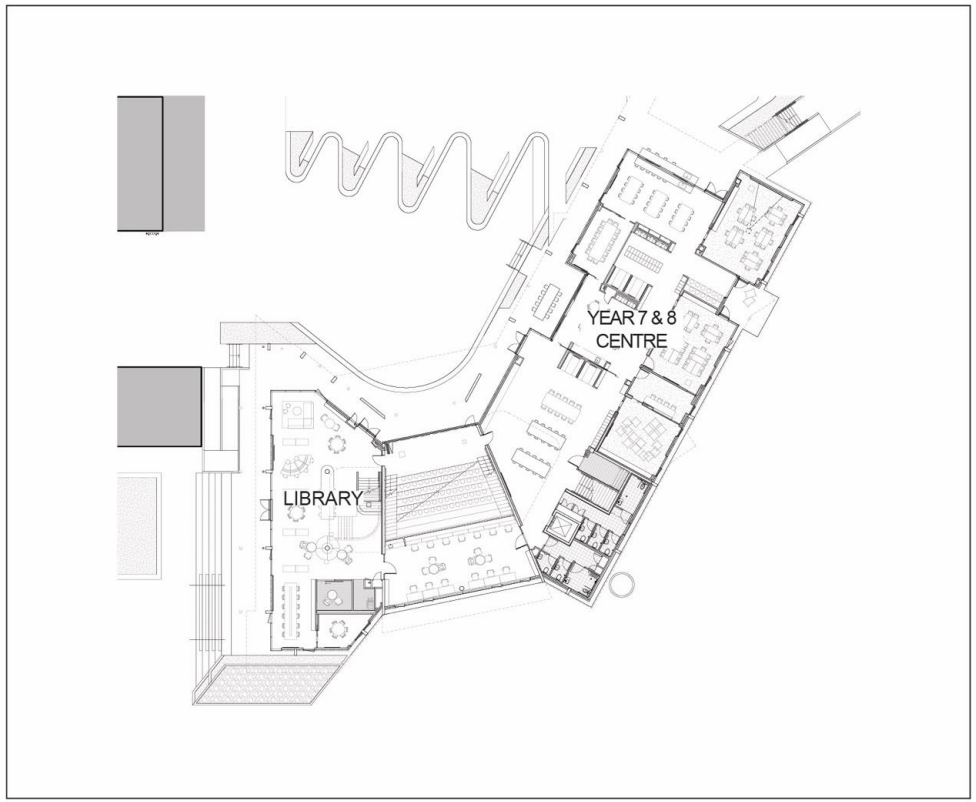
Site Context

Aerial view of existing site.
Source: https://maps.six.nsw.gov.au



Site plan showing proposed new Year 7 and 8 Building and Library
Drawing courtesy of Hayball Architects

School B - New library and Year 7 and 8 centre



Proposed Year 7 & 8 and Library Building - Ground Floor Plan
Drawing courtesy of Hayball Architects

Proposed Year 7 & 8 and Library Building - First Floor Plan
Drawing courtesy of Hayball Architects