Wesley Imms · Thomas Kvan *Editors*

Teacher Transition into Innovative Learning Environments

A Global Perspective

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Preface

Occasionally, events in research conspire to move our thinking ahead with a jolt. This book is an outcome of such serendipitous events. For more than a decade the Learning Environments Applied Research Network (LEaRN) from The University of Melbourne's faculties of Education and Architecture conducted high-level research projects, many for the Australian Research Council. Each added another layer of knowledge to what we knew about good design and use of learning environments in schools, hospitals and the like. These were always done in consultation with relevant industry groups, but its *Innovative Learning Environments and Teacher Change* (ILETC) project leveraged those accomplishments to an unprecedented collaboration with industries and education departments across four nations, and equally importantly, to early career and established researchers in more than 12 countries. As part of this, and in addition to co-generating knowledge across borders, ILETC was unique in hosting learning environment research conferences in Melbourne (Australia), Michigan (USA), Copenhagen (Denmark), London (England) and Phoenix (USA). Each drew on Ph.D. projects or recently completed research projects from a mass of countries to gain, to some degree, a global understanding of the latest evidence being found on the good use of innovative learning environments.

Teacher Transition into Innovative Learning Environments—A Global Perspective comes from the 2017 *Transitions* suite of conferences in three countries. Its purpose is firstly to illustrate the extraordinary range of projects that constitutes an effective agenda of ILE research; and secondly to showcase examples of that work. The message is clear—if we are intending to provide an evidence base of 'what works', simple solutions do not exist. The task of maximising the effectiveness of ILEs is complex and multi-faceted, it requires research across the paradigms, it requires an international approach, it requires collaboration between industries and education organisations, it requires imaginative and lateral thinking, and most critically it requires a great deal of support and time.

The book in part celebrates accomplishments along this journey; it is reassuring to see this quality of work being done internationally, and across a breadth of topics. It also helps us 'stream' or categorise the complexity of this work. *Transitions* is structured according to the predominant themes that emerged from these conferences; Inhabitation of Design, Change and Risk, Measuring Impact, and Teacher Practices. The sections contain three or four examples of the research that addresses each respective issue. Each does so while reflecting the context of particular countries. Each does so from the perspective of a range of professionals such as architects, acousticians, academic researchers, educators and designers.

This is, indeed, a rare publication; a cornucopia of perspectives, foci, contexts and research approaches. It takes advantage of a rare combination of situations and events to advance our thinking on a complex but critically important topic. *Teacher Transition into Innovative Learning Environments—A Global Perspective* focuses on the need to know as much as possible about the way teachers can be helped to maximise the unique qualities of ILEs. This was a focus of the hosting ILETC project and reflects evidence from educational research that quality of teaching is the single factor that exerts the greatest influence on improving students' learning experiences.

Acknowledgements
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Special thanks are due to Kenn Fisher for his assistance in the writing of the section introductions.

Innovative Learning Environments and Teacher Change project; Partner Organisations

Ministry of Education, New Zealand (NZ)
New South Wales Education Department (Aus)
Queensland Education Department, (Aus)
Australian Capital Territory, Education Department, (Aus)
Catholic Education Office, Parramatta, (Aus)
Learning Environments, Australasia, (Aus & NZ)
Churchie (The Anglican Church Grammar School), (Aus)
Australian Science and Mathematics School, (Aus)
Woodleigh School, (Aus)
Hayball Architects, (Aus)
Powerhouse Museum, Sydney, (Aus)
Microsoft Education, (USA & Aus)
DLR Group, (USA)

Ecophon, (Sweden)
Steelcase Education (USA & HK)
Telstra Australia, (Aus)
Marshall Day Acoustics, (Aus)

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About the Editors

Wesley Imms (Australia) comes to learning environments research from a long period as a teacher, then through a Ph.D. in Curriculum Studies from the University of British Columbia in Canada. His teaching spanned art and design education, his practice for decades has included designing and building ‘crafted’ homes, and his artworks have focused on bespoke purposeful furniture construction, which he exhibits annually. For the last decade, these interests have conflated into applied research programs, where he specialises in assisting schools conceptualise, inhabit, refine and evaluate learning environments. This work has focused extensively on large-scale collaborative projects that draw heavily on international industry participation, and with an emphasis on Ph.D. and Masters level input to this knowledge generation. He is a co-Director of the LEaRN group, manages LEaRN@MGSE, and through selected consultancies he works closely with schools in the Asia-Pacific region on improving the use of innovative learning environments. Wesley is currently an Associate Professor at The University of Melbourne, Australia.

Thomas Kvan (Australia) is recognised for his pioneering work in design, digital environments and design management and has held senior leadership roles in several universities as Dean and Pro Vice-chancellor. He was the founding co-Director of LEaRN (the Learning Environments Applied Research Network) delivering multidisciplinary research on learning and architecture, and was founding Director of AURIN (the Australian Urban Research Information Network) that developed a national digital infrastructure, both networks hosted at The University of Melbourne. He has published over 180 publications in academic, professional and popular channels. He is currently founding Dean of the School of Design at the South University of Science and Technology (SUSTech) in China.

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Space Are Places in Which We Learn

Thomas Kvan

Abstract We make and occupy spaces for purposeful activities. Significant investments are made in learning spaces in schools without adequate consideration of pedagogical and architectural issues. This chapter notes that it is a broad and multifaceted challenge to guide capital investments that deliver better learning outcomes in schools. It introduces the research presented in this volume and some of the underlying concepts and considerations embedded in the work of LEaRN and the projects described in following chapters.

At the start of the twentieth century, John Dewey published great insights into the state of education and the experience of children in schools (Dewey 2001). In particular he wrote of the benefits of organising learning around activity and purpose and that the school rooms (as he called them) needed to provide for active occupation. He observed that the rooms he knew necessitated behaviours of the children that were not conducive to that mode of learning, instead promoting passivity and thus disengagement. The obvious connection between the design of places of learning, schools and their outcomes has been widely engaged from both design and pedagogical perspectives.[1]

The work of our research network, LEaRN,[2] was initiated at a time when considerable financial capital was being directed to extending school facilities in our local community, that of the state of Victoria in Australia. You can find similar programmes of building and refurbishing schools across the world at various times, and unfortunately the converse, periods of neglect. Communities and governments appear to act periodically, responding to such factors as demographic shifts, reprioritisation

[1]For example, Sanoff, H. (1994). School Design. John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158, and Uline, C. L., & Tanner, C. K. (2009). Effects of school design on student outcomes. Journal of Educational Administration.

[2]More information on the learning environments applied research network can be found online at https://research.unimelb.edu.au/learnetwork/home (accessed 10 December 2019).

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of budgets, political manifestos or as a capital stimulus for a faltering economy or perhaps simply shame. The investment in Victoria (a State of Australia) in 2008 was prompted by several such factors and was accompanied by questions of how to make such an investment effective for the declared purpose, that of learning.

The challenge of identifying if the investments have been effective is a complex one, as illustrated by the range of projects undertaken by our research network. All of these research projects have enquired into the large question of how to ensure that capital investments are well used by considering the diverse aspects of the question, drawing on the knowledge, ways of enquiring (sometimes called ways of knowing), methodologies and assumptions of different disciplines. The editors and authors in this book reflect the value of such diversity; my co-editor, Wesley Imms, draws on his deep knowledge of pedagogy and I from my experience in design.

Gaining strength from this diverse multidisciplinary background, projects in LEaRN have considered learning environments from a range of perspectives. We might summarise these as what we do, how we do it and how do we know what we have done. Some projects have examined construction techniques to understand if the most sustainable and cost-effective means are deployed to enable rapid response to changes in education demand. Other projects addressed the need for robust assessment criteria and methods for completed projects so that the lessons learned can be cycled back into the future school building. We have been commissioned to write guidelines for such future projects and we have assisted schools to use their facilities to achieve better learning outcomes.

Other projects have taken a more pedagogical perspective across different stages of learning, extending to examining the learning of students in primary up to tertiary systems, including particular cohorts such as special needs students or medical students on the wards. Recognising that schools serve broader purposes beyond the tasks of learning; we are also looking at how the sites can better serve as community hubs. All the projects are conducted collaboratively with partner schools, school districts, designers, industry suppliers and communities, with academic researchers taking the lead to organise and run the research.

The Innovative Learning Environments and Teacher Change (ILETC) project, which is the formal context from which this book emerges, is one project within this portfolio of projects. It was framed specifically at how we can help teachers to use the untapped potential of Innovative Learning Environments (ILEs) to improve learning outcomes for students. In particular the project wished to probe the contentious questions as to whether there *is* a link between quality teaching and effective use of the spaces in which they teach. In answering that question, the project sought to develop practical tools to assist teachers to adapt their teaching practices to maximise deeper learning.

The unspoken assumption in the work presented in this book is that we are all describing a place in which learning takes place. The participants, whatever their roles, congregate in one location to engage collectively in the activities, and the place is developed to facilitate these activities. We use resources to invest the site with features, facilities and meaning that enable the outcomes to be realised. We make these places, the schools, into sites where we can learn. We also know that this is not a work that can be completed, every insight brings opportunity and new questions. It is action research that informs work in progress. As such, we publish what we know, incomplete and unresolved. This book reflects a state of knowledge and opportunities in the next steps.

It's Where We Are

Instinctively, we all care about the spaces in which we conduct our daily lives. We seek out cafés that we find comfortable, we prefer certain parks or gardens when looking to relax, we complain to co-workers about the offices we are assigned, we spend our resources to make homes that respond to our needs. In all of these we are making an implicit assumption that space affects the way we behave and think, whether relaxing or concentrating, whether conducting mundane tasks or creative invention, whether we are learning or performing rote actions.

These instinctual decisions recognise that the spatial setting of our activity has some influence on our performance, that we relax more effectively in one place than in another or learn better in one school than another. This tacit understanding is often illustrated by a quote from Winston Churchill in 1943, 'We shape our buildings, and afterwards our buildings shape us' (United Kingdom 1943). In that debate about the proposed reconstruction of the House of Commons that had been severely damaged by German bombs in 1941, Churchill argued that the narrow rectilinear form of the chamber forced debaters to take clear positions, unlike a semi-circular space that facilitated subtle nuances by displacements along an arc. He argued too that there should be fewer seats than members so that there were no reserved seats, members had to respond to circumstances in their seating arrangements and hence could not retreat behind convention but could engage in spontaneous conversation. At key moments, the space would be overcrowded, the overcrowding itself adding urgency to the debate underway. In these comments, Churchill identified that the theatre of a space, its habitation, was a key and that the way the space affected the community engaged within it was an essential component to the particular practice of British parliamentary democracy.

It's the Way We Act

The connection that Churchill had identified is that the act of gathering to engage in a purpose is affected by the space in so far as the way the members of the particular community disport and participate is influenced by the geometry. In his argument, he addressed the conventions, cultures and conveniences, connecting these to the location in which they were enacted. Specifically, he was arguing for the reconstruction of a narrow debating chamber too small for the number of members and thus not meeting our contemporary understanding of 'functional space' but reinterpreting 'functionality' to consider behaviours that may emerge because of the particularities of the space, its crowdedness, the narrowness. His argument was that our behaviours in the space make us, not the space itself. This is indeed the perspective we take, that the users of the spaces are in control, they make decisions about the use of the space and the experiences within.

What Is It About the Space?

The influence of the space on behaviour may be considered in a formal sense—if we are in a library, we behave as we should by some sense of convention of that library. It may be the semiotics of the spaces that bring behavioural change about—we can be conditioned to read the sign *Library* and react by lowering our voices and adopt other behavioural norms.

In effecting such a reaction, we have relied on our sight to read the sign and interpret this to behaviour. Our eyes can inform us of intentions through colour choices, sharp delineations between contrasting colours noting purposeful boundaries, or shifts from primary colours to pastels to indicate more subtle changes.

Other human senses can also be conduits for the message. An auditory threshold between a 'bright'[3] space and a more muted one can lead to a tacit reaction of dropping the volume of your voice and adjusting action such as adjusting your pace.

Each of our senses can be engaged in this way. Bakeries that vent onto the street the smells of freshly made goods encourage us to linger or move on, as can sound and light qualities in other contexts.

While such factors are considered in the design of learning spaces, there are often more subtle factors than those registered by our primary senses. Several papers in this volume have explored the implicit enablers of spatial engagement, the affordances of a space.

It's Our Choice

While Dewey did not write explicitly about innovations in classroom design, his ideas have been influential in the emergence of other forms of learning environments and classroom designs. As Cuffaro (1995) notes, 'within a Deweyian framework the classroom environment demands primary attention'. She notes that few teachers will ever participate in the design process for new facilities, typically finding themselves assigned to an existing space and 'dealing with the unyieldingness of plumbing features and doorways'. She summarises with the observation that the important

[3]A term used to describe a space that has surfaces that reflect noise readily, privileging noises in the upper registers, so the space comes to be filled with competing sharp sounds.

contribution of the teacher is in 'the choices we make, the physical and social arrangements we create'.

A common misunderstanding of Churchill's statement is that architectural design is deterministic, that space can cause an outcome. While we might respond to spaces by lowering our voice or moving slower, the effect is not determined, it is interpreted and suggested. The human actor in the space determines how they will behave. In summary, whether we respond to the opportunity offered by a particular space or collection of spaces is our choice, individually and collectively.

Our response can be to physical properties of the spaces, such as the light or sound, but also how we act or perform within the space. In all these the geometry of space and surface properties will influence us. Transparent walls connect our space to others; transformable or moveable items, furniture, walls, lights, allow us to control the experience. We can engage with space actively by using these properties, or passively and continue as ever.

What we do within the space is also to be considered. In daily life, we adapt our actions to a setting and in others we use the setting to enhance our actions. The act of teaching is not immutable; even the most seasoned of teachers are constantly reacting and responding to changes in demography, curricula, popular culture and professional insights. If we perceive an opportunity in a room, we use it. When the physical space no longer suffices, we adapt, we workaround, we hack.

Our reaction though is a choice and with that we consequently take on responsibility. The decision we make is driven primarily by the intention; whatever our role, we are in the place to help students learn. The goal is an alignment for purpose and outcome. There are multiple guides to our decisions such as prior experience; tacit and conveyed knowledge; cultural assumptions and constraints; and our perception of inherent risks and the potential. Schools are a collective engagement, so the action in one learning space is not isolated from those elsewhere in the school. The collaboration is within the class and across the classes, conveyed by the culture of the institution and the behaviours within. A significant challenge though is that of undertaking change. Change is imbued with risk and our reaction is in part a mitigation of this risk, a constructive engagement of the risk.

If spaces are not determinist, the design of learning environments is therefore focussed on the provision of opportunity, delivering spaces that have the potential to accommodate, satisfy or enable a variety of desired experiences.

Making Informed Choices

While I have been writing this from the perspective of the teacher rather than the student, both students and teachers react to the space in which they are engaged in learning. The chapters in this book reflect both perspectives, as well as those of school leaders. At the centre of our focus is what happens in the space at the moment of learning. Everyone in the room will respond to the task, the space and the moment.

For some, their role is to anticipate and prepare for the task, for others it is to engage in the performance of the task.

A key purpose of the research in LEaRN is to inform our choices and to assist in change. The following chapters have been grouped loosely into four sections that reflect dimensions in which choice is made: Change & Risk, Habitation, Measurement and Teacher Practice. The contents of papers naturally cross between the sections, so an interest in one aspect may lead you to read papers in another section. Each section is introduced with a brief overview of the papers, here you might find guidance to related topics.

The collection starts with a consideration of the change that teaching practice is undergoing when it is adapted to new environments. As I noted above, change is inherently risky, although stasis is also imbued with risk but often assumed to be risk-free. Seldom is change wholesale; instead, changes can be made across the range of factors. In our focus, it may be practices, physical features or temporal. Obviously, change must also be made in a coherent and coordinated manner, otherwise change in one aspect is obviated by lack of change elsewhere. While we observe that good teachers can teach well in almost any setting, even their effectiveness can be hobbled by poor leadership or frustrated by inadequate settings. Thus, we can conclude that some changes are positive advances, other changes might be undertaken in mitigation.

When we enter a space new to us and our intended activity, we naturally engage in some assessment of the environment. Some may do so explicitly, testing the acoustics or manipulating the lighting or changing the disposition of the furniture. Others may be less explicit in their adaptation, reacting tacitly to features and feedback. Howsoever we do this, we are inhabiting the space but also to cohabit with those around us, either the students in the room or the teachers and students in adjoining spaces. The act of habitation is a negotiation with animate and inanimate, conversing with the mutable and accommodating the immutable.

Choice must be informed, otherwise it is blind. A central driver of the research within LEaRN has been to inform our choices by providing means to measure change so that future change can be understood. The metrics must address the broad range of factors that affect outcomes of change.

Ultimately, the goal of change is to enable more effective learning and to assist teachers with these responsibilities by providing research-based insights as to what improved learning might be, how it might be supported and how new learning environments offer opportunities for such outcomes. Most immediately, therefore, the insights in the chapters will be of use to teachers in their particular contexts, complementing their portfolios of capabilities they draw upon to guide students towards good learning outcomes.

The chapters will also be of value to school leaders and education policymakers as they provide perspectives on how opportunities for change are realised provided that policies allow for the initiative. The benefits need not be driven by capital investments but where those are necessary, the interpretation for action might lead to other than prescribed.

With the multidisciplinary team that has conducted the research, we are able also to offer insights in the design of innovative learning environments, discussing examples from several places in the world and examine their use.

While each of these aspects is in itself of importance, perhaps the most valuable consequence of the research presented here is the integration of perspectives. Wesley Imms addresses this specifically in his chapter where he writes about the interpretation and application of the research insights and how these suggest our next challenges. The summative lesson to be drawn from the work presented here is that this is a work in progress and that the field is ever-evolving.

This chapter has illustrated that guiding capital investments in schools to deliver better outcomes is a broad and multifaceted challenge. The value of the investments may be primarily intended to help students learn more effectively or more deeply, but that outcome can be affected by many factors. While that is a primary focus, the many other ways in which schools contribute to communities can also be considered. Research has an important role in illuminating this and helping us to make our choices.

References

Cuffaro, H. K. (1995). *Experimenting with the world: John Dewey and the early childhood classroom.* Teachers College Press.

Dewey, J. (2001). *The school and society & the child and the curriculum.* NY: Mineola.

United Kingdom. (1943). House of Commons. *Debates*: 28 October.

Thomas Kvan (Australia) is recognised for his pioneering work in design, digital environments and design management and has held senior leadership roles in several universities as Dean and Pro Vice Chancellor. He was the founding co-Director of LEaRN (the Learning Environments Applied Research Network) delivering multidisciplinary research on learning and architecture, and was founding Director of AURIN (the Australian Urban Research Information Network) that developed a national digital infrastructure, both networks hosted at The University of Melbourne. He has published over 180 publications in academic, professional and popular channels. He is currently founding Dean of the School of Design at the Southern University of Science and Technology (SUSTech) in China.

Co-creating Innovative Learning Environments: LEaRN's Decade of Discovery

Kenn Fisher

Abstract This forward provides an overview of earlier LEaRN work carried out leading up to this book. It also explores some of the pedagogy and spatial tropes which have emerged over past decades. Whilst there have been many explorative innovations over that time, very few have been scalable and sufficiently resilient to dislodge the primordial hold that the Industrial Age classroom has taken in school design for over a century. Many attempts have been made to align pedagogy and space, but the classical classroom learning container remains in large part due to teacher mindsets. The Transitions suggested in these chapters may well be a seminal moment in the history of school design as the ILETC project nears its final stages of discovery.

Context

The work that this book covers is the latest manuscript emerging from a succession of nested projects commencing in 2007 at The University of Melbourne. This series of connected projects carried out since 2007 were largely directed towards understanding and developing an evidence-base on the nature of the relationship between student learning and the design of learning environments. These studies included various Australian Research Council Grant-funded projects, a number of large research consultancies with education departments, and several University-funded seed grant projects.

The projects were all completed under the aegis of the cross-disciplinary Learning Environments Applied Research Network (LEaRN) which was founded in 2008 by the Melbourne School of Design; the Melbourne Graduate School of Education; and the Melbourne Medical School. Collaborating institutional industry partners included schools and ministries of education, with industry professional practice partners consisting of various companies from the school building procurement sector.

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These research and consulting studies have sequentially tackled the emergence and the effectiveness of innovative learning environments with a view to seeking links to their impact on student learning outcomes. However, few of these studies focused significantly on the practice of teachers. Furthermore, much of the literature in the educational discourse does not consider the impact of the physical learning environment on teacher practice. Indeed, there is a significant silence in the role of space in educational environments and how space and place may be integral to the whole teaching and learning process (Dovey & Fisher, 2014).

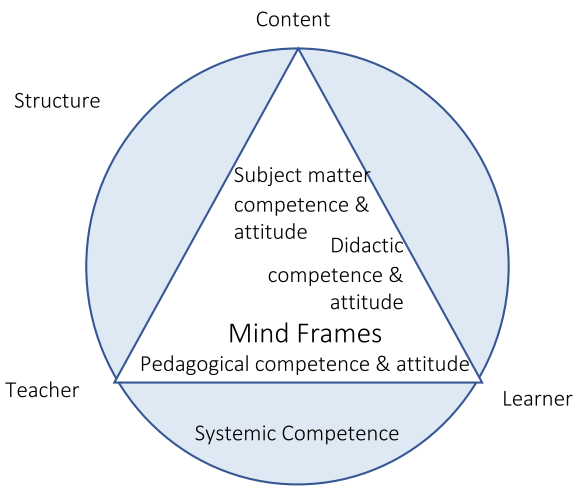
Teaching and Learning Theories

Nevertheless, there is a massive amount of peer-reviewed research on both teaching and learning and currently there are many models of both in practice in schools worldwide. Teaching and learning are both at the heart of school education, supported by the curriculum and various complementary systems as illustrated by Zierer (2015) (Fig. 1).

Zierer's (2015) use of the term didactic is, in German parlance, related to teaching being based on post-enlightenment evidence-based content and knowledge. Moving into the twenty-first century, where increasingly dialectic or Socratic models of teaching are being used to promote active learning practices, there needs to be significantly more focus addressed to the supporting structures in education, of which both the physical and virtual environments combined are a critical part.

Zierer's (2015) use of the term 'mind frames' (after Hattie, 2012) is important here as it highlights the connection between historic teaching practices—which are now habituated—and current attempts at a more progressive teaching practice. Indeed the word innovation is now ubiquitous in education, yet such an approach—i.e.

Fig. 1 Teacher 'expertise' domains (Zierer, 2015). Used with permission from Klaus Zierer and the publisher: Taylor & Francis Ltd, http://www.tandfonline.com)



innovation—seems to evade the principle of scalability. These innovations whilst widespread remain isolated examples of what is possible. It has been said[1] that ‘the future is here it is just not widely distributed’.

This edited book on innovative learning environments and teacher change research builds on the succession of studies carried out through LEaRN, but is now turning the lens towards teacher practice and ways in which the ‘habits of mind’ of teachers can be transitioned in both the virtual and physical worlds to support an innovative teaching practice. In these prior studies by LEaRN it was found that the attributes of Hattie’s (2012) eight Socratic led teacher mind frames suggest that teachers aspire to:

- Believe that their fundamental task is to evaluate the effect of their teaching on students’ learning and achievement.
- Believe that the success of students is based on what teachers do (or don’t do).
- Want to coach and model different ways of learning, rather than teaching.
- See assessment as feedback about their impact.
- Engage in dialogue, not monologue.
- Enjoy a challenge and never retreat to just ‘doing their best’.
- Believe that it is their role to develop positive relationships in learning spaces and staffrooms.
- Inform parents about the nature of learning.

In drawing on both Hattie’s (2012) and Dovey & Fisher’s (2014) work on the spatiality of these potential Socratic teaching approaches, it was proposed that teaching practices—or activities—could be summarised as follows, although clearly there are many more activities that are possible which are not itemised in this simplistic listing:

- Teacher facilitated presentation, direct instruction or large group discussion.
- Teacher facilitated small group discussion or instruction.
- *Team* teacher facilitated presentation, direct instruction or large group discussion.
- Collaborative/shared learning, supported by teachers as needed.
- One-on-one instruction.
- Individual learning.

These activities imply related learning spaces or affordances to support those pedagogical practices. What is now very well established in school operations is the use of data to inform teaching practice. Put another way, teaching practice should be evidence-based. But, as noted above, there is little extant evidence on how teachers use space in contemporary practice.

There is, however, a long history of attempting to link pedagogy and space going back over a *millennium.*

[1] Attributed to William Gibson in a radio interview in 1993.

A Brief Genealogy of the Evidence-Based Design of Learning Environments

Early evidence first emerges when the then growing Islamic faith developed madrasa schools associated with mosques in the 8thC (Esposito, 2003). Some of these schools later evolved into the earliest universities e.g. the University of Al-Karaouine (859AD). A century or so later in the Western world cathedral schools emerged in association with monasteries. Some of these also transformed into universities including the Universities of Bologna (1088), Oxford (1096) and Cambridge (1209).

Abassi (2009)[2] notes that it was at the earliest stages of the Industrial Revolution (with the invention of the steam engine in circa 1712[3]) that a more formal spatial approach to school education emerged in villages and cities with the acquisition and adaptation of various existing buildings. These soon morphed into the form of monitorial classrooms of the late 18thC, led by Drs Bell (1752–1832) and Lancaster (1776–1838). In the United States these were known as Lancastrian Schools[4]. These schools consisted of larger halls for 300 or so pupils seated in rows of desks with (student) monitors allocated to each section, together with space provided in the access ways at the sides for students to stand in semi-circles to observe lesson boards attached to the hall walls. These early arrangements were more focussed around student discipline management rather than student needs or teaching practice. Markus (1993, p92.) notes that:

> In the monitorial schools the prescription for individual posture, gesture and eye contact were as detailed as those for groups of bodies controlled by painted lines or brass strips on the floor and monitors' rules. The face, and especially the eyes, signified character and willingness to learn. The sloping floor, the raised master's platform, the raked gallery and the tiered desks were direct instruments for visual surveillance.

In 1870 the United Kingdom Elementary Education Act introduced compulsory primary school education, whilst this also became the norm in the USA in 1918[5] (this policy delay was most likely due to the State-based control of schooling in the USA). In this early UK building 'boom' the halls were subdivided into classrooms, where double desks were spaced so that teachers could move between them. Window sills were kept above eye level to minimise distractions.

Parallels existed in the United States, until Dewey (1916) sought to stimulate students through a more socially engaged form of learning related to lived experiences and the social construction of knowledge. This suggested more progressive building typologies such as Hillside Home School (Lloyd-Wright, 1902)[6], which developed in parallel with a (global) health and hygiene approach in an attempt to combat disease epidemics at that time.

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[2] A number of doctoral graduates from LEaRN have reviewed the historical development of school planning and design.

[3] http://www.softschools.com/timelines/industrial_revolution_timeline/40/.

[4] https://www.raceforward.org/research/reports/historical-timeline-public-education-us.

[5] https://people.howstuffworks.com/public-schools1.htm.

[6] https://www.flwright.org/researchexplore/wrightbuildings/hillsidehomeschool.

After the First World War, as early modernism evolved, so did the concepts and theories of Freud and Jung, resulting in a suite of more radical school designs linked to the ideas of Montessori, Steiner and Isaacs, particularly in relation to early childhood development (Graham, 2008). Subsequent to the Second World War 'open air schools' emerged essentially modelled on modernist democratic principles although not really articulating a more democratic internal spatial arrangement. They were more about the outdoors. This was accompanied by the advent of 'bells and cells' or the 'eggcrate' spatial arrangements that proliferated at that time, many of which exist and persist to this day.

These post Second World War developments are covered by Abassi (2009) and also Darian-Smith & Willis (2016) with the latter's book on 20thC school design and pedagogy. This book leads the evidence-based trajectory into the exemplary work of the Educational Facilities Laboratory (Marks, 2009) which was established in the United States in 1958, operating until 1986. This was more or less replaced a decade later in 1998 by the Educational Facilities Clearinghouse (EFL, 2019) a national US Government imitative attempt to provide some national 'guidelines' to the fifty or so State government school systems.

Mention is made by Abbasi and Darian-Smith & Willis (2016) of many innovative examples which were not scaled but, apart from the massive expansion of modularised often precast 'cells and bells' schools in the 1960s to accommodate the emerging 'baby boomer' growth in student numbers, the most significant scaled innovative development was the 'open plan schools' movement of the 1970s. This (what turned out to be a flawed) experiment has had much written about the reasons for its failure (Logan, 2016).

The concept was originally conceived to reflect the democratised 'open' curriculum of that time—some readers will remember the civil unrest of the late 1960s—in the design of the school i.e. a 'school without walls'. But the spatial innovation came without teacher professional development, no proper attention to acoustics in the open plan areas, and little access to the technologies that are becoming ubiquitous today, which are increasing the ability of students to work in personalised and self-directed ways.

Fast forward to Chap. 18 (Dussel, 2016) in Darian-Smith & Willis (2016), and we now encounter the same open classroom problematic—how to make schooling authentic and connected to the outside world in a physical sense, whereas in a virtual sense connection is immutable?

This digital and Socratic (re-)evolution was specifically targeted by Australia's Victorian Department of Education when the Blueprint for Government Schools was developed in 2003 (Pike, 2005). Since then the Department has invested some AUS$4 to 5 billion in new school designs, many—if not all—being innovative and bespoke to their local community following the previous Premier Jeff Kennett's launching of self-governing schools, whilst also cutting 7,000 school jobs and closing 350 schools (Knight, 1998). To this day all Victorian Schools have a self-Governing Council which has the power to select their architects.

Such a Blueprint for space change warranted a deep consideration and re-evaluation of the 1970s open school movement. The Victorian Department of Education initiated a study (Fisher, 2005) which aimed at 'linking pedagogy to space'. This approach received some international attention and was adapted for use in the United Kingdom's GBP55 Billion 'Building Schools for the Future' capital works programme in 2007 (BSF, 2019).

Subsequently, the establishment of LEaRN heralded a highly successful succession of research projects including Federal, State and Independent Sector grant funding totalling some $5 million over the first decade (LEaRN, 2019).

This edited book, and the ILETC project—along with the additional LEaRN studies—has built upon the earlier work developed for the Victorian Education Department.

Linking Pedagogy to Space

It was decided by the ILETC team to use the spatial typologies of Dovey & Fisher (2014) as a key framework to survey 800 schools across Australia and New Zealand to ascertain the extent to which each school advised that they were using innovative teaching and learning practices, and to what extent they were applying these approaches in matching innovative learning spaces. These spaces ranged from traditional classrooms (Type A, Fig. 2.) through a mix of classrooms and breakout spaces (Type B) to combined environments illustrated in Type E. The classroom layouts and the resulting data from the 800 schools are illustrated in Figs. 2, 3 and 4. The ILETC study then went on to explore the relationship between perceived 'deep learning' of students' and the teacher mind frame extent of adaptivity as shown in Fig. 3.

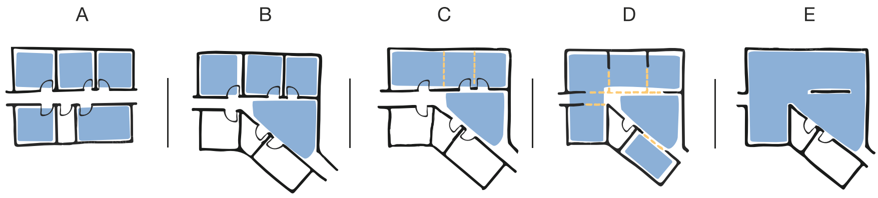
Finally, the relationship between teacher practices, deep learning and the spatial typology were examined as illustrated in Fig. 4.

The editors of this book—both Chief Investigators on this ILETC project—thus were able to build on the progression of the LEaRN body of work from its founding.

This led to two successive parallel ILETC international Transitions conferences (held in the USA and Europe) to gain a greater global understanding of the emerging evidence of these relationships. The transitions conferences were attended by 80–100 participants on each continent with the invited peer-reviewed conference presentations transformed into book chapters. These were in turn peer-reviewed to finalise the shortlist of chapter authors herein.

Having gained an international oversight of teacher mind frames, deep learning, teacher practice and spatial typologies it was then necessary to refocus the lens to a more granular level in examining the integral components of teaching and learning educational systems.

The 16 selected final chapters were clustered into four themes, namely (1) *Change & Risk*—Creating a space: users and design; Agency and teacher collaboration in ILE; Achieving 'buzz'; Mitigating risk & improved impact of ILE; Pedarchitecture; Interaction design research triangle for reading spaces; (2) *Habitation*—Mobility



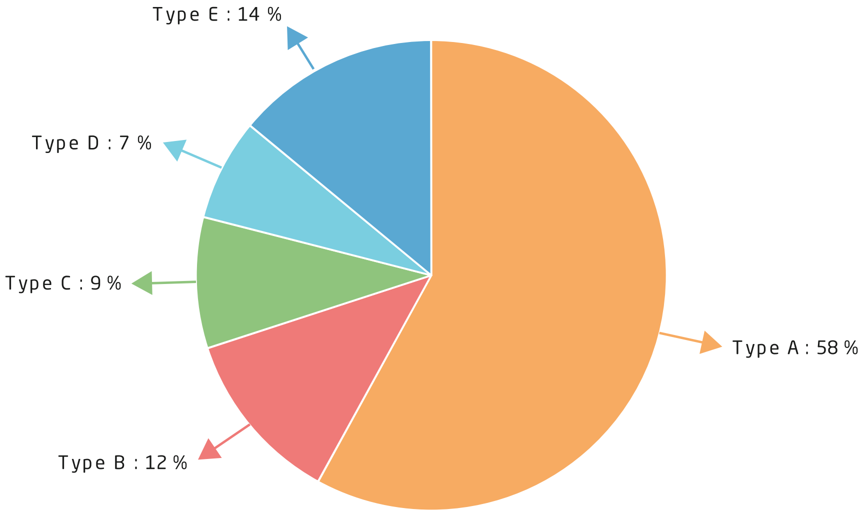


Fig. 2 Classroom typologies and School preferences in which to teach in an ILE format (Source: Imms, Mahat, Byers, and Murphy (2017). Reprinted with permission from the ILETC Project)

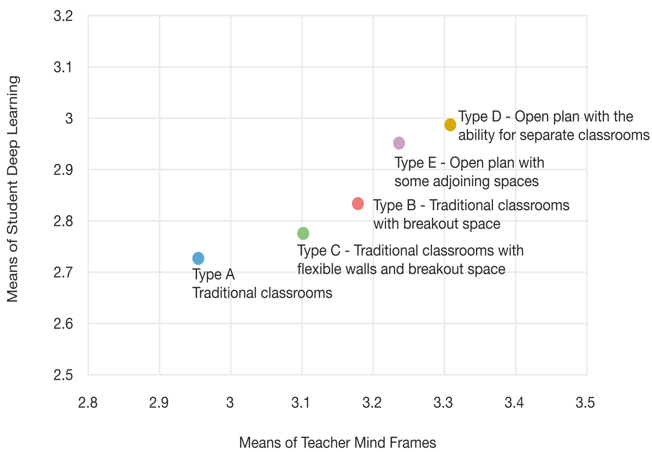


Fig. 3 Relationship between 'deep learning', teacher mind frame and spatial typology (Source: Imms et al. (2017). Reprinted with permission from the ILETC Project)

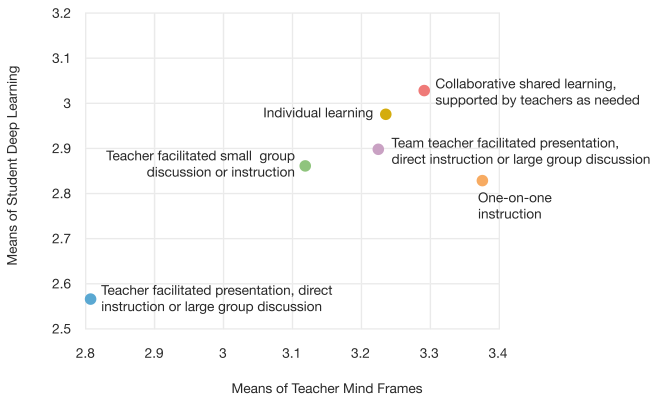


Fig. 4 Means of teacher mind frames and student deep learning categorised by most prevalent teaching approaches (Source: Imms (2017). Reprinted with permission from the ILETC Project)

of people for collaboration; Gadfly Collaborative data; Inclusive ILE's re acoustics; Interaction Geography; (3) *Measurement*—What does teaching and learning look like in ILE's; Lighting; Learning spaces and student learning; and Flaring and focusing.

The last section is a culmination of the research into praxis i.e. (4) *Teacher Practice*—The spirit of 'we'; ILE and socio-spatial entanglements for practice; and the 'Hack the school' toolkit.

What is very evident in the concept of Transitions is the wholistic nature of the variety of activities and enterprises into what is arguably a Transitions Ecosystem (Fig. 5).

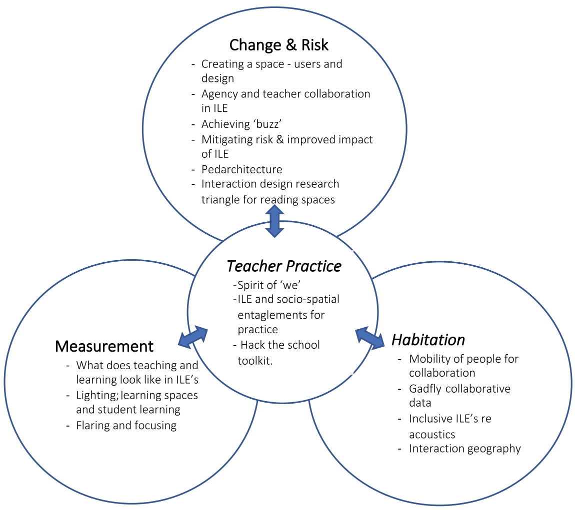


Fig. 5 Key interactions within the ILETC Transitions Ecosystem for teacher practice

The ILETC Transitions Ecosystem

Figure 5 illustrates how all of the elements in a Transitions Ecosystem interact with each other as articulated by the Editors in the structure of this book. Each element must be considered synchronously with each other for the ILE outcome to be triangulated and resilient. The four key categories are considered by the Editors in a particular order and are discussed in this order by the editors as preambles to each of the four book sections.

It is also necessary to agree on an internationally shared understanding of what an innovative learning environment is. Working against this notion is the primarily culturally specific nature of education at the school level. Every nation—and indeed many provinces and states of those nations—have their own specific educational approaches, nomenclature and agreed standards. It is thus difficult for a project such as this to use an agreed terminology for ILE's.

Fortunately, there are two global organisations which can assist in identifying a shared definition.

Firstly, the Organisation for Economic Co-operation and Development (OECD) had embarked on an innovative learning environments project around the same time as this ILETC project. Thus, the Editors were able to draw from that work to obtain an accepted term for ILE which could be shared by the international participants in the project. Rather than a single statement of what an ILE 'is', the OECD suggested seven principles that serve to shape an ILE. These are the learning environment:

– Recognises the learners as its core participants, encourages their active engagement and develops in them an understanding of their own activity as learners.
– Is founded on the social nature of learning and actively encourages well-organised co-operative learning.
– The learning professionals within the learning environment are highly attuned to the learners' motivations and the key role of emotions in achievement.
– Is acutely sensitive to the individual differences among the learners in it, including their prior knowledge.
– Devises programmes that demand hard work and challenge from all without excessive overload.
– Operates with clarity of expectations and deploys assessment strategies consistent with these expectations; there is strong emphasis on formative feedback to support learning.
– Strongly promotes "horizontal connectedness" across areas of knowledge and subjects as well as to the community and the wider world.

(Source: OECD, 2017, p25)

The OECD study also asks about ILE's:

– *Learning focused:* How learning focus is the network and how far might it be characterised as innovative?

– *The means of innovation "contagion":* The nature of the diffusion within networks and how they spread learning innovation.
– *Formal/non-formal balance:* How informally networked are formal learning environments; how visible is the non-formal and do the formal and non-formal combine in new "hybrids"?

(Source: OECD, 2017, p81)

Many of these issues are covered neatly in the matrix in as illustrated in Table 1. Indeed, the Chapters in this edited book could be considered to be implementing the transformative Phase 4 of Table 1.

The second global institution, the United Nations Educational, Scientific and Cultural Organisation (UNESCO 2019), developed a Learning Portal to cover many of the same issues as the OECD, although they do tend to cover different socio-economic demographics, that is to say, developing countries. That said, it is important to consider what innovation means in different countries. In some countries innovation may simply be just having a school to go to, let alone the sophistication of some of the more elite private schools we see in Australia, for example.

The UNESCO Institute for Information Technologies in Education (IITE, 2019) is increasingly tackling some of the more global issues through the lens of innovation. For example, a Ministerial Forum (UNESCO, 2019) picks up on the 'leap' of the use of technology in the developing world, where the virtual is perhaps becoming more viable than the physical in terms of available capital expenditure.

Perhaps the 'elephant in the room' in all of these above observations is how to scale up the concept of an ILE across a national or state school ecosystem.

As noted earlier, the chapters in this book explores some of the issues I have raised, particularly in the Transforming phase of the table above. The contributed research chapters are bookended by chapters from the co-editors—Chap. 1 sets the scene and contextualises the work of LEaRN; Chap. 20 reflects on the contributions in that context and points to the next steps. The other chapters are presented in four sections, each with an introductory essay authored by the editors and myself. This structure will assist the reader to delve into the issues found most pertinent to each reader.

Concluding Remarks: Evidence-Based Design and Translational Research

This edited book showcases some very innovative research projects-in-progress focussing on transitioning strategies. Within the ILETC project there is emerging a very solid evidence-base of learned material on innovative learning environments. Such a scholarly body of work is difficult to inscribe in the literature, as much learning environment research does not meet sufficient Evidence-Based Design standards or is so multidisciplinary the publication venues can become very opaque.

Table 1 Phases of Transition in implementing an ICT strategy (Source: Groff, 2013)

Phase Criteria	Phase 1 Emerging	Phase 2 Applying	Phase 3 Integrating	Phase 4 Transforming
Vision	Limited, pragmatic, dominated by interested individuals	Driven by ICT specialists	Driven by subject specialists	Entire learning community
Teaching, Learning & Pedagogy	Teacher centred	Teacher centred, ICT is a separate subject	Learner centred, collaborative	Critical thinking, preferred learning styles
Development Plan & Policies	Accidental, restrictive, no planned funding	Limited, centralised policies	Individual subject plans for ICT, permissive policies	ICT is integral to overall school development plan (budget, professional development, etc.)
Facilities & Resources	Limited and non-current digital resources, restricted access	Diverse and varying in model, platform; aligned with specific content and pedagogies	Diffused access to various digital resources; supports to implement these in various ways	Whole school learning and diverse learning environments; web-based learning spaces, distance education, student self-management software
Understanding of Curriculum	ICT literacy, responsibility of individual teachers	Use of software and applications in discrete subject (isolated)	Integrated, resource-based learning, problem-solving, project methodology	Virtual and real time contexts, modelling, integrated curriculum delivery via the web
Professional Development	Individual interest	Training on ICT applications unplanned	Subject specific, evolving	Integrated learning community, innovative, self-managed, personal vision and plan

(continued)

Table 1 (continued)

Phase Criteria	Phase 1 Emerging	Phase 2 Applying	Phase 3 Integrating	Phase 4 Transforming
Community	Accidental	Some parental and community involvement	Subject-based community, providing occasional guidance; global and local networked communities	Broad-based learning community involving families, business, industry, organisations, universities; school as a learning resource for the community
Assessment	Responsibility of individual teacher, didactic, paper and pencil based	Teacher centres and subject focussed	Learner centred, subject oriented, integrated, multiple media to demonstrate alignment	Continuous, holistic, open-ended, project-based, learning community involvement

This compares to evidence-based medicine which is accepted globally, as a given. This medical concept—known as 'translational medicine'—has been adapted over the past couple of decades within health planning practice (HERD, 2019). But, in educational architecture, a deep evidence-based body of research knowledge on human–environment interaction in school education is still emerging. More importantly, the interaction between research and practice is even less evident in educational architecture. Although this dual-sector is not alone:

> 'Research is research, and practice is practice, and never the twain shall meet. The gap between these two communities is real and frustrating'. (Norman, 2010)

In response to this dilemma, Norman argues for an integrative approach to research theory and practice through the modality of 'Translational Development'.

> Between research and practice a new, third discipline must be inserted, one that can translate between the abstractions of research and the practicalities of practice. We need a discipline of translational development. Medicine, biology, and the health sciences have been the first to recognise the need for this intermediary step through the funding and development of centres for translational science. This intermediate field is needed in all arenas of research. It is of special importance to our community. We need translational developers who can act as the intermediary, translating research findings into the language of practical development and business while also translating the needs of business into issues that researchers can address. Notice that the need for translation goes in both directions: from research to practice and from practice to research (Norman, 2010).

For school design practitioners, we thus would have:

Translational Research ⇒ Translational Development ⇒ Translational Engineering ⇒ Translational Design

There is currently a cross-disciplinary practice emerging of 'Educational Planning' (A4LE, 2019), which is modelled on the abovementioned health planning sector[7]. This development is reflecting the complex cross-disciplinary processes that underpin the development of effective resilient (complex adaptive) innovative learning environments. This edited book is arguably a compilation of the Educational Planning research efforts of the invited authors, the majority who mix research and practice on a daily basis.

A final word on 'culture'. It seems to this writer that much of the above is bounded by cultures—tribal, territorial, discipline and a host of others which will impact on transitions. Indeed, there are no doubt multiple teacher cultural mindsets (Nahavandi, 2019) which have to be considered when we head—or transition—into the relative unknown in developing innovative learning environments.

May there be many more such scholarly books to accompany this exhaustively researched one.

References

Abassi, N. (2009). *A Pathway to a better personal and social life through learning spaces: The role of school design in adolescents' identity formation.* Unpublished Doctoral Dissertation, University of Melbourne.

A4LE. (2019). The Association for Learning Environments.

BSF. (2019). UK Building Schools for the Future capital works programme. https://www.nao.org.uk/report/the-building-schools-for-the-future-programme-renewing-the-secondary-school-estate/.

Darian-Smith, K., & Willis, J. (Eds.). (2016). *Designing schools: Space, place & pedagogy*. London & New York: Routledge.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education.* New York: MacMillan.

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio- spatial assemblage. *The Journal of Architecture., 19*(1), 43–63.

Dussel, I. (2016). Digital classrooms and the new economies of attention: Reflections on the end of schooling as confinement. In: Darian-Smith, K., & Willis, J. (Eds.), *Designing schools: Space, place & pedagogy*. London & New York: Routledge.

EFL. (2019). Educational facilities clearinghouse. http://www.ncef.org.

Esposito, J., & Burgat, F. (2003). *Modernizing islam: Religion in the public sphere in the middle east and Europe*. Rutgers University Press. New Jersey.

Fisher, K. (2005). *Proposed planning principles: Linking pedagogy and space*. Melbourne: Victorian Department of Education and Early Childhood Development (DEECD). https://www.education.vic.gov.au/documents/school/principals/infrastructure/pedagogyspace.pdf.

Graham, P. (2008). Susan isaacs and the malting house school. *Journal of Child Psychotherapy, 34*(1), 5–22.

[7]In regulating such planners, there is now a move to accreditation: The Accredited Learning Environment Planner (ALEP)

Groff, J. (2013). Technology-rich innovative learning environments. *OECD Innovative Learning Environments project*. https://www.oecd-ilibrary.org/content/publication/9789264203488-en.
Hattie, J. (2012). *Visible learning for teachers*. London & New York: Routledge.
HERD. (2019). *Health Environment Research and Design Journal*.
IITE. (2019). UNESCO Institute for information technologies in education. Ministerial Forum. Global dialogue on ICT and education innovation—Towards a sustainable development goal for education (SDG4). Proceedings. Moscow.
Imms, W., Mahat, M., Byers, T., & Murphy, D. (2017). *Type and use of innovative learning environments in Australasian schools*. In: ILETC Survey No. 1. Melbourne, Australia: University of Melbourne, LeARN. Retrieved from http://www.iletc.com.au/publications/reports.
Knight, T. (1998, August). Struggle for a new public democracy: School community and the State. In: *Paper Presented at the British Education Research Association Annual Conference*. Belfast: The Queens University.
LEaRN. (2019). The Learning Environments Applied Research Network. https://research.unimelb.edu.au/learnetwork/home and https://research.unimelb.edu.au/learnetwork/home#projects.
Lloyd-Wright, F. (1902). Hillside home school. Sourced from Frank Lloyd wright trust database. https://www.flwright.org/researchexplore/wrightbuildings/hillsidehomeschool
Logan, C. (2016). Open shut them: open classrooms in Australian Schools, 1967–1983. In K. Darian-Smith & J. Willis (2017). (Eds)., *Designing schools: Space, place & pedagogy*. London & New York: Routledge.
Marks, J. (2009). *A history of Educational Facilities Laboratories (EFL)*. National Clearing House of Educational Facilities. http://www.ncef.org.
Markus, T. (1993). *Buildings & power: Freedom and control in the origin of modern building types*. London & New York: Routledge.
Nahavandi, A. (2019). https://www.culturalmindset.org/partners and https://catcher.sandiego.edu/items/soles/Cultural%20Mindset_Nahavandi.pdf.
Norman, D. (2010). The research practice gap. *Association for Computing Machinery (ACM) Journal 'Inspirations'*, *17*(4).
OECD. (2017). *The OECD Handbook for Innovative Learning Environments*. Paris: Centre for Research and Innovation.
Pike, B. (2005). http://web.education.unimelb.edu.au/curriculumpoliciesproject/Reports/download/Vic-2005-BlueprintforGovernmentSchools2003.pdf.
UNESCO. (2018). Proceedings of the Ministerial Forum: Global dialogue on ICT and education innovation—towards sustainable development goal for education (SDG 4), April. Moscow.
UNESCO. (2019). https://learningportal.iiep.unesco.org/en/issue-briefs/improve-learning/schools-and-classrooms/the-psycho-social-school-environment; https://iite.unesco.org/about-unesco-iite/.
Zierer, K. (2015). Educational expertise: the concept of 'mind frames' as an integrative model for professionalisation in teaching. *Oxford Review of Education, 41*(6), 782–798.

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Change and Risk

Introduction to Part I: Change and Risk

Thomas Kvan and Kenn Fisher

Abstract This section presents research in managing change and risk inherent in the introduction of new learning environments. The topic is introduced, and a brief review is given for each chapter in the following section.

A focus on new learning outcomes provokes changes in teaching practice and calls us to consider new types of spaces in which the learning takes place. Change is fraught with risk yet, obviously, the opportunity cannot be realised without engaging that risk.

New learning environments might be an outcome of desired change in a school, they may be imposed by funding agencies that have adopted new standards as yet tried by a particular school, or they may arrive by other routes. While risk management might typically seek to minimise risk, the schools and their communities (leaders, teachers, students and more) might 'grasp the nettle' and seek to realise benefits from change. As Bradbeer notes in his contribution in this section, 'teachers often finding themselves in a space between practicality and potential'. How then might they go about developing the potential and seek the practicality.

The process might start ahead of the delivery, if all is going well. Design literature has noted that good design outcomes are delivered when designers, clients and users are active in their participation. As Bojer writes in her chapter that in ILEs, these players are the architects, the institution and the teacher. The aspiration is difficult to realise unless actively engaged. She asserts that for an ILE to be 'intentional', the process of inclusive design must ensure the alignment of creative teaching, the school organisation and the space. The actual spatial formative process is a learning process. This is described as 'research through design' although this is not a simple process as it is participatory and co-constructed/designed. Five phases are posited: research, define, ideate, prototype and handover. Bojer proposes that the

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last is an ‘activation phase’ in which the players engage in a participatory process of activation, that is to bring a project into use once it is constructed. This extends the participatory design process by carrying responsibilities to occupancy. There is often a considerable period of time between design briefing, during which the players will be engaged in describing what they wish to achieve in a project, and by the handover after construction the individuals involved may have moved on and others taken their places. Thus, projects often experience discontinuities of intent and practice, resulting in diminution of value in the result and no change in practices to enable better learning outcomes. Bojer concludes by noting that space itself will not change pedagogy but better engagement in the process of delivering learning spaces will benefit outcomes: ‘the teachers cannot be expected to know how to use the ILEs as a tool if they are not involved directly or indirectly in the design process to match pedagogical practices with the intentions of the space’.

Bradbeer then examines ‘the role of pedagogical and organisational structures alongside levels of autonomy experienced by teachers on adapting to new spaces’ and observes ‘tensions may be felt between predominating or created structures, and aspired or idealised practice’. An action research-based practising deputy primary school principal, Bradbeer recognises that successful innovative learning environments require equally successful collaborative teachers. This team or co-teaching approach, in contrast to the very habituated model of school education we all still live with, requires significant curating of agency, autonomy and adaptation with teachers to transition to an alignment between pedagogy and space. Bradbeer coined the phrase ‘differentiated teaching requires differentiated spaces’, a comment that is effectively the motto for the significant change management program of the New Zealand Ministry of Education Modern Learning Environments project (NZ MoE, 2019). Bradbeer’s research is an essential contribution in understanding the extensive transitions efforts in change management and risk mitigation. His chapter in this book examines the transition that teachers must navigate as they leave teaching practice conducted in a context of autonomy and spatial isolation and embark in ILEs on a practice of collaboration and proximity to others. He addresses the agency and self-management that support these different modes of practice through structuration theory, identifying that temporal, spatial, organisational and linguistic structures are active in addition to the physical, spatial structures. By approaching these structures as enabling rather than constraining, Bradbeer illuminates how the transition into ILEs can be better understood and therefore enacted.

While appropriate structures of the kinds Brabeer identifies are essential, so too are specific structures to address risk and to assist the participants through its successful translation from negative consequences to positive outcomes. French in a similar vein wonders what a successful innovative learning environment looks like. She examines the transitions into ILE and seeks to characterise successful transitions. Aspects of such transitions examined include four key facets: organisational enablers, such as a shared language with which to engage; the relationships between the key actors (students, teachers); purposeful structures; and maintaining a culture of risk. Her chapter develops further examination of purposeful structures, what she calls ‘layered scaffolding’, that provide the appropriate degree of support and guidance required for successful transitions. She describes these as multi-layered, from policy bodies (government departments, school councils) to those developed at the individual level. It is the presence of these scaffolds that characterise contexts of successful transitions and she notes that these scaffolds and the transitions they enable are powerful tools to develop further change to support innovative learning.

Key players in these transitions are the teachers and the chapter by Jones and Le Fevre seeks to identify teacher perceptions of risk—with associated barriers—in endeavouring to establish ways of mitigating these through communities of practice (Wenger, McDermott & Snyder, 2002) and address how teachers can be equipped to manage the risk of change. In particular they consider 'perceptions of risk' and how these can be barriers to change. Success in change is therefore considered through a better awareness of these perceptions. The authors define risk as 'loss, significance of loss and uncertainties'. All three of these can have a profound impact and effect on individual teachers and a mitigation strategy is essential to enhance the likelihood of an innovative learning environment succeeding in a resilient fashion. They note that 'the unquestioning acceptance of ingrained personal practical theories of teaching may result in teachers closing themselves off to learning how to work in ILEs'. The chapter explores risk and uncertainty, importantly noting that risk is a social construct (risk in one community may not be considered such in another) and the ways in which such risks are validated and addressed are also situated. In this framing, realising the potential of a new situation (the change to an ILE) will have locally defined risks, including those perceived by the teacher and school leaders. Their research articulates these risks and the contexts in which they are perceived, concluding with observations on implications for policy and practice. Their conclusions include adopting a 'communities of practice' approach to share the risk taking and mitigation strategies, thereby avoiding the self-induced risk aversion.

With the background on the contexts and management of risk to deliver improved learning experiences, we turn in the final two chapters to the practice within the places created. Marcarini considers schools in Italy and Denmark to reflect on the duality of space and learning and how the two aspects are both actively engaged in enabling better learning. This learning experience can be personalised for a student as the teacher recognises the opportunities in a space and draw upon their practice to exploit the opportunities. She identifies that the two are inter-related. New approaches to teaching permit the better use of new spatial opportunities and new spatial opportunities enable new approaches to teaching. Her analysis illustrates that an awareness of the duality and the contributions of the leadership and the students themselves are necessary in translating the challenges of change into opportunities for discovery. She sees the development of a 'bridge culture' as an enhancement of co- and team- teaching, as it posits a broader organisational and systemic shift in school culture overall, not just in the co-teaching cohorts of students. In summary she suggests that such a 'collective practice that builds together shared social meanings' re-purposes the school culture itself as 'real' third educator.

By focusing on a specific learning activity, Dyer considers the contribution of spatial affordances to the specific activity of learning to read. Engaging with the idea of affordances (Gibson 1977), she draws on Fallman's (2008) 'interaction design research triangle', a model which forms a three-way relationship between design practice, design studies and design exploration. Dyer uses literacy education which itself seeks to connect beginner readers to the content, their emotions/bodies and the spaces they are inhabiting. The connection of literacy to spatiality is rarely made so this is a unique and risky change strategy to take. However, Comber & Nixon (2008) do offer a 'safety net' for this approach. This review thus illuminates a design process linked to a learning outcome. As such, it illustrates how teaching practice can inform the conceptualisation and realisation of pedagogical space and design activity.

References

Comber, B., & Nixon, H. (2008). Spatial literacies, design texts, and emergent pedagogies in purposeful literacy curriculum. *Pedagogies: An International Journal*, *3*(4), 221–240.

Fallman, D. (2008). The interaction design research triangle of design practice, design studies, and design exploration. *Design Issues, 24*(3), 4–18.

Gibson, J. (1977). The theory of affordances. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting and knowing*. Hillsdale, NJ: Lawrence Erlbaum Associates.

NZ MoE. (2019). New Zealand Modern Learning Environments. http://www.education.govt.nz/school/property/state-schools/design-standards/flexible-learning-spaces/.

Wenger, E., McDermott, R., & Snyder, W. (2002). *Cultivating communities of practice*. Harvard Business School Press.

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Creating a Space for Innovative Learning: The Importance of Engaging the Users in the Design Process

Bodil Bøjer

Abstract Based on an empirical case study, this chapter puts forward the thesis that in order for an innovative learning environment (ILE) to work as intended, three things must be aligned: teaching (the teacher), space (the designer) and organisation (the school management). Ideally, when designing new ILEs all three factors are considered in the design process in order to ensure a common goal: creating the best space for innovative learning. In reality, this rarely happens and the users are left with a physical learning environment where the intentions do not always match educators' expectations and established practices. To remedy this dilemma, the chapter proposes an additional activation phase in the design process after implementation—that is, the early use phase of a new build—where the intentions of the space are translated into actions, and refinements negotiated through discussions with the users through a participatory process. The purpose of this phase is to match pedagogies with spatial possibilities. The methodology used is Research through Design.

Introduction

Space shapes us but we are also affected by the way we interact with and act within the space. Within learning environment contexts, the interdependence between the physical space, innovative teaching and the organisation of a school is often overlooked when designing ILEs. This may be because there are often expectations that a new spatial design will automatically change the way we teach and learn. However, we know that simply changing the space is not enough (Imms & Byers, 2017); the intentions of the space can only be fully realised if the users of the learning environments are aware of and support the pedagogical principles informing the provision of these spaces (Burke, 2016). Unfortunately, the pedagogies that a project is expected to facilitate often remain unstated, or may even be unknown by those who are to use the facilities (Jamieson, Fisher, Gilding, Taylor, & Trevitt, 2000).

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Blackmore, Bateman, Loughlin, O'Mara, & Aranda (2011) argue the way a building is inhabited is at least as important as the quality of its design. But on this, there is no convincing body of research that proves any causal link between a new learning space and pedagogic change (Mulcahy, Cleveland, & Aberton, 2015); space and furnishing do not automatically lead to certain actions or learning processes. That is because such change is mostly about relationships and changing cultures and practices (Blackmore et al., 2011). Arguably, the use of space depends on the receiver (Kirkeby, 2006) and the organisation of the school. Beghetto & Kaufman (2014) point out that the organisation of, or leadership within a school plays a key role in establishing an environment supportive of creativity, which is why just changing the physical settings or pedagogical methods does not guarantee innovative learning. A good learning environment requires congruence between physical space, pedagogical practices and the organisation of the school (Ricken, 2010).

In this chapter, an ILE is understood to be the combination of an innovative space that supports a wide range of learning needs and situations, often through the provision of a highly flexible interior and purpose-built furniture and innovative teaching and learning. The terms 'innovative teaching' and 'innovative learning' are used throughout this chapter to denote teaching and learning activities that in combination and through their focus on deep-learning foster the so-called 'Twenty-first Century learning skills' of creativity, collaboration, communication and critical thinking in students and assist in the best possible student learning outcomes, as explained by Mahat, Bradbeer, Byers, and Imms (2018). Hence, innovative teaching and learning strategies are about engaging the students in situated and inquiry-based learning, allowing for experimentation and immersion in subjects of interest (Tanggaard, 2014). The physical design of ILEs range from large open spaces to highly flexible arrangements of classrooms that can be reconfigured into different kinds of learning spaces (Imms, Mahat, Byers, & Murphy, 2017). Imms and Byers (2017) describe three types of learning spaces that are found in many educational institutions today:'formal' or traditional classrooms focused on largely didactic pedagogies, student-centred spaces focused on transactional approaches to instruction and a 'third space', where social activities overlap informal and active learning activities. These new learning environments provide the infrastructure to inspire teachers to reconceptualise and rethink their teaching. It seems clear that ILEs require a new way of teaching (Imms, Cleveland, & Fisher, 2016) due to their particular spatial layouts that do not support 'classical' teacher-centred teaching. Instead, ILEs provide a physical setting for collaboration, experimentation and exploration, which are central activities (amongst others) in learning processes that foster creativity and innovation (Craft, 2005; Cropley, 2001; Tanggaard, 2014).

A Participatory and Practice-Based Research Approach

Designers tend to be separated from the final users of the physical environment by facility management professionals, which makes the renegotiation of architecture-pedagogy assumptions quite difficult, according to Jamieson et al. (2000). However, to establish the best conditions for innovative learning, it is my thesis that alignment between teaching (the teacher), space (the designer) and organisation (school management) is necessary, as illustrated in Fig. 1.

To create this alignment, I propose a participatory form of design processes where both users (teachers and students) and school management are included in the design process regularly to align needs, wishes and intentions continuously in order to assure ownership and use of the space. Blackmore et al. (2011), drawing on Higgins, Hall, Wall, Woolner, and McCaughey (2005) and others, emphasise that 'participatory or generative design involving students and teachers needs to continue throughout all phases—from design to evaluation—in order to achieve sustainable impact within a rapidly changing context' (p. 37). User involvement tends to improve the understanding of needs, resulting in a more suitable building (Clark, 2010; cited in: Könings, Bovill, & Woolner, 2017). I will elaborate on this in the following chapter, based on a specific case where a new ILE was designed at a municipal primary and lower secondary school near Copenhagen, Denmark in collaboration with the design agency Rune Fjord Studio. To maintain the privacy of the employees and students the school is only referred to as the municipal school.

The research approach used in this particular case is Research through Design (RtD), which allows the researcher to generate new knowledge through processes that simultaneously develop, test and improve design in relation to a specific spatial environment. The role of the designer is thereby merged with the role of the researcher. The methodology of RtD was first described by Christopher Frayling in 1993 and covers a research approach where the design process in itself becomes a way to

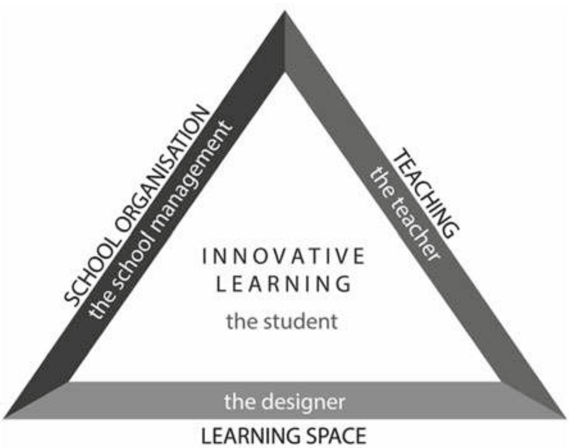

Fig. 1 An alignment between teaching (the teacher), space (the designer) and organisation (the school management) is necessary in order to establish the best conditions for innovative learning. Diagram by Rune Fjord Studio

acquire new knowledge. RtD investigates the research inquiry from the practitioner's methods and acknowledges practice as a means of gaining new knowledge, which in this project means developing concrete spatial environments while working in an iterative dialogue with a physical material and the users that reflect back on the research. Research reflections are generated in action (Schön, 1983) through the design process and concrete design proposals.

The Assignment and the Intentions of the New ILE

In 2016, the design company Rune Fjord Studio was asked to design an ILE in a street-space connecting classrooms used by 3rd to 5th-grade students at a municipal school in Copenhagen, Denmark. The street-space can be explained as an open learning space, big enough for activity and circulation, that cannot be closed into classrooms and is exposed to major traffic as the primary access to other learning spaces (Dovey & Fisher, 2014). The new premise was as for this development to be used for both formal and informal learning and free play during regular school hours and after school activities, which meant that it had to cover many different functions and transform easily.

Jamieson, Dane and Lippman (2005) claim that spaces outside the classroom cease to exist as transition spaces and become learning spaces in their own rights when they are layered for different ways of learning. Learning environments outside the classroom tend to be less constrained by the educational traditions and habits that often reign in the classroom, I would argue. Transformed into a layered environment with various workstations, these spaces potentially provide opportunities for promoting individual, one-to-one, small group and large group activities where the student takes on a more active role in the learning process. According to research, certain pedagogical strategies allow the students to actively engage in the learning process and become immersed in a topic of interest over a longer time as well as experiment, play and examine open-ended problems promote critical thinking and help develop creative and innovative skills (e.g. Craft, 2005; Cropley, 2001; Tanggaard, 2014). To support this, the space was redesigned with different activity zones, flexibility and diversity in workstations that allow for many types of activities and learning styles as opposed to the original interior consisting only of groups of chairs and tables (see Figs. 2, 3, 4 and 5). A set of purpose-built furniture aimed at supporting the needs and ideas of this particular school as well as innovative learning was especially developed for the space. This included two transformable co-creation cabinets designed as potential tools in innovative processes, one as a mobile design studio and the other as a tool for presentation (see Fig. 6).

Fig. 2 The original learning environment at the municipal school. Drawing by Rune Fjord Studio

A Participatory Design Process to Align Teaching, Space and Organisation

The triad of relations between teaching (teacher), space (designer) and organisation (school management) served as the starting point for the design process of the new ILE. A graphic diagram of the design process, inspired by the Double Diamond model by the British Design Council (Council, 2007), served as a tool to keep track of when to involve the different stakeholders in the project. The diagram visualised the four phases of the design process (see Fig. 7), Understand & Discover, Analyse & Define, Develop & Design and Production & Implementation, which respectively opened and closed the process through divergent and convergent thinking (for more information about design processes see for example Lawson, 2006).

The intentions were to involve all key stakeholders directly or indirectly during the design process on a regular basis. In reality, this was not possible because of budgets, tight deadlines and teachers' workloads. Könings et al. (2017) describe how participation in the design of learning environments is crucial in order to account for the different expectations and perceptions of stakeholders, but might be limited by contrasting expertise, cultures and priorities—or in this case, project restrictions and other circumstances.

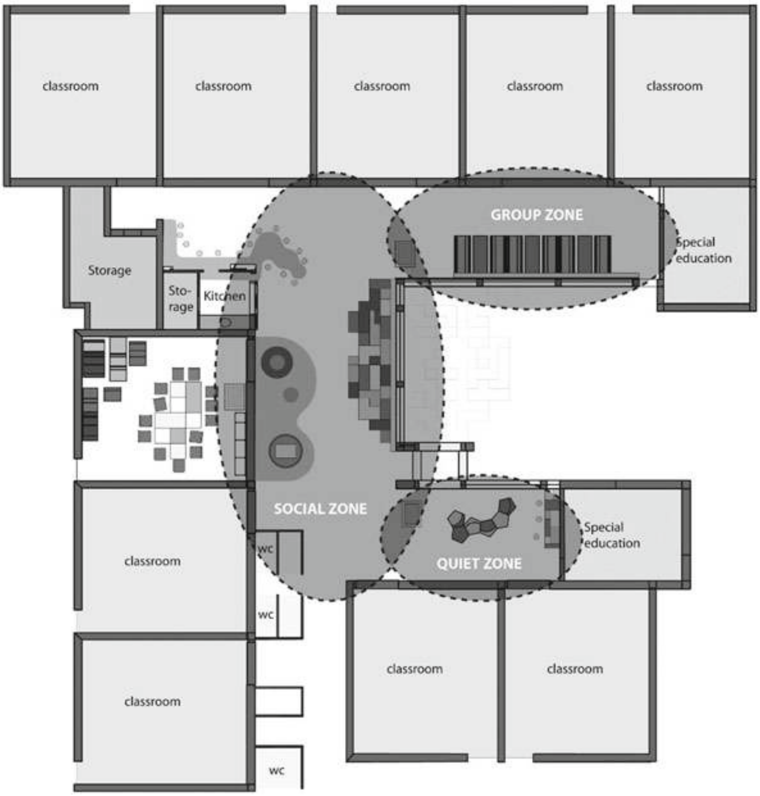

Fig. 3 The innovative learning environment at the municipal school, divided into 3 activity zones: Quiet Zone, Social Zone and Group Zone with a diversity of workstations and flexible furniture. Drawing by Rune Fjord Studio

Initial insights into the needs, wishes, organisation and pedagogies of the municipal school were obtained from the school management prior to the design process, and regular communication between school management and designers were held throughout the project. In addition to this, ethnographic methods such as photo-mapping and observations were performed during the pre-design phase to collect empirical data that served as a groundwork for the spatial design.

Most user involvements took place during the first phase in which two workshops were held with a group of users to collect information that could lay the foundation for the designing of the space. Only one teacher, two pedagogues (the teachers working in the afterschool club) and school management participated in the first workshop (all teachers were invited) and approximately 30 students and parents took part in the second workshop. The other teachers were informed about the design process regularly by the school management with an invitation to comment on the design but had no direct contact with the designers.

Fig. 4 Diners for collaborative work in the group zone. Photographer: Filipa Pita, Rune Fjord Studio

Without Keys the Spaces Are Hard to Unlock

The ILE at the municipal school was designed as an active street-space, connecting the nine classrooms with the rest of the school and the outside playground. This typology, where classrooms still play the main part in the teaching and learning situations, arguably requires less from the teachers in terms of changed pedagogies compared to open-plan learning spaces. Still, the teachers in this case experienced a high level of difficulty adjusting to the possibilities and limitations of the new space (personal communication, 17 Aug, 7 Nov, 11 Nov 2017), which will be explained further in the following sections. In contrast to this, the students intuitively adapted to the possibilities of the ILE, choosing freely amongst workstations when given the chance (vice-principal, personal communication, 13 June 2017).

Three months after implementation the designers returned to observe the use of the ILE and experienced a large variation in how much space was used by the different classes. Whereas one teacher took advantage of the variety of workstations in the ILE by working in a dynamic flow between the classroom and the ILE, others stayed inside the classroom for the whole day or used it sporadically. The transformable co-creation cabinets remained unused.

Subsequently, the designers met with the teaching team during one of their monthly departmental meetings to discuss and evaluate the intentions behind the design. During this meeting, the designers discovered that not only were many teachers unaware of the intentions behind the spatial design, they did not even know that they were allowed to use the co-creation cabinets, to the extent of not having access to the units' keys. Furthermore, the teachers found it hard to manage the use of the ILE, being nine classes sharing the new facilities. In an attempt to activate the

Fig. 5 Learning landscape and high table in the social zone where many learning activities can be accommodated simultaneously. Photographer: Filipa Pita, Rune Fjord Studio

ILE, the teachers were subsequently encouraged to use the space and purpose-built furniture according to intentions and to share experiences with each other on their monthly team meetings in order to inspire and create a joint work culture.

One year later, when revisiting the school, very little had changed in terms of pedagogical practices. Before redesigning the space, the teachers had fixed rules about where and how many students from each class to let out into the street-space. These rules were back in use, which meant that the ILE was not being used according to activity and affordance of the space or learner needs, but according to a teacher made division and teacher needs. The co-creation cabinets remained unused. Lackney (2008) explains this retreat to old practices as a result of the teachers not being trained in how to utilise the affordances of the space; they retreat to the safety of default practices (Cited in: Byers, Imms, & Hartnell-Young, 2014).

Fig. 6 Co-creation cabinets. Photographer: Filipa Pita, Rune Fjord Studio

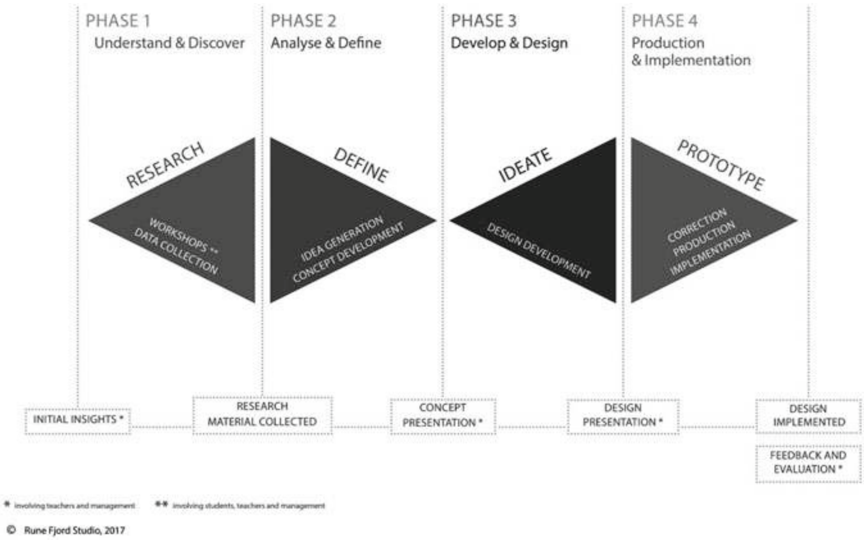

Fig. 7 A design process model in four phases by Bodil Bøjer and Rune Fjord Studio, inspired by the Double Diamond model by the British Design Council

Participatory Processes Are not Uncomplicated

In retrospect, more effort should have been made to involve the teachers in the design process that would arguably create a common vision and perhaps facilitate the proposed alignment illustrated in Fig. 1. School management easily engaged in the process, presumably because they were the contracting authority, but it was difficult to engage the teachers. This resulted in very limited direct communication between teachers and designers. The exact reasons for this are unknown, but prospectively the challenge will be to secure the involvement of all parties during the design process of new learning environments.

The difficulty of aligning the space with the teachers' usual way of teaching indicates that the intended partnership between teaching, organisation and space did not happen during the design process. With the exception of one teacher, they were neither directly nor indirectly involved in the design process, resulting in a mismatch between design intentions and pedagogical practices, limited awareness of the intentions of the space, and a lack of ownership for the new design. While any transition from one teaching method to another is complicated, greater involvement in the design process arguably makes this transition easier and increases the chance that new designs and pedagogies correspond. Jamieson et al. (2005) stress the importance of bringing together the key stakeholders during the design process, which demands a visionary strategy for the project prior to the design phase to establish a common language and an overall understanding of the teaching strategy and different learning activities. Furthermore, they claim that the teachers should be guided into using the new types of learning spaces, which is backed up by Lackney (2008). Similarly, Blackmore et al. (2011) emphasise that new built spaces will not move teachers to innovative pedagogies unless they are prepared and provided with the necessary skills, tools and resources to change their practices.

An Additional Phase to Activate the Space

Therefore, I propose that a fifth phase, called here Delivery and Activation, is added to the design process (see Fig. 8) with the purpose of handing over and activating the project in collaboration with the users. The aim of this phase would be to match spatial possibilities with pedagogical practices. Very often, the interaction between creators and users of learning spaces abruptly ends as soon as a new design has been implemented, which leaves the users with a spatial design they might not know how to use. Without a strong leader and a common vision to push the project forward, the new design risks becoming an obstacle instead of an asset for teachers and students.

As explained earlier, the intentions of a new spatial design can be difficult to decode. During 'Delivery & Activation' the intentions of the space are translated into actual pedagogic and learning actions, the nature of these negotiated with the users, preferably students and teachers, through a participatory process. This needs

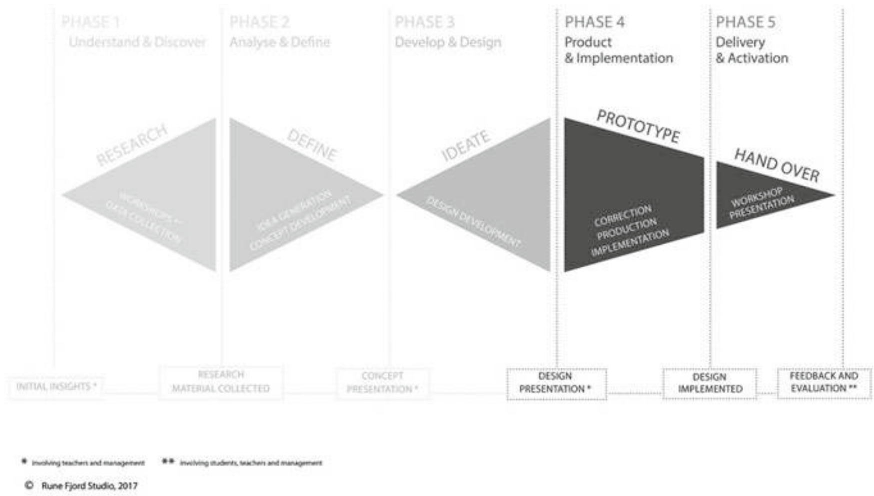

Fig. 8 The design process model with a fifth phase for delivery and activation by Bodil Bøjer and Rune Fjord Studio

to be recognised as an ongoing process where a common language and culture are established because activation is never totally finished. School design is ongoing (Blackmore et al., 2011) as it constantly develops and transforms with its users. As concluded by Higgins et al. (2005, p. 3)

> …in a changing world no design solution will last forever, so the process of user involvement must be continually refreshed and iterated to support ongoing change. This approach has the added benefit of sustaining the meta-cognitive and motivational power of user involvement in creating the environment over time.

The actual content of this phase requires further development. It is likely there is no one way to do this, with the phase looking different in each learning space and according to different pedagogical strategies. Könings et al. (2017) propose facilitation and visual activities as a means to engage participants and encourage the sharing of ideas. In this particular research project, a participatory toolkit to help unlock the potential of ILEs based on perspectives of co-design is currently being explored in several Danish schools. The aim is to examine whether co-design methods can help create a higher level of spatial awareness and competencies, thereby potentially becoming a tool in the design process when designing new learning spaces, or a tool for activation of already existing spaces in appropriation with the users. The term co-design refers to design activities where designers and non-designers work together to develop new designs. The co-design approach has been chosen as it actively includes the participants in the design activities and has the potential to initiate a discussion about abstract pedagogical philosophical issues through a very concrete subject like e.g. the layout and experience of a learning space. Co-design differs from other discussions about possible futures by actively exploring what to achieve and how to achieve it in combination, using a broad repertoire of tools and techniques (Brandt, Binder, & Sanders, 2012; Sanders, Brandt, & Binder, 2010).

Conclusions

ILEs are being built across the world in order to foster twenty-first- century learning skills such as creativity and collaboration. In this chapter, I have proposed that in order for the ILEs to work as intended and to become a tool for improved pedagogical practices, three things must correspond: teaching (the teacher), space (the designer) and organisation (the school management). This has been exemplified in a case study at a Danish school, where a design process model was used in an attempt to engage all participants in the design process of a new ILE and through this create accordance between teaching, space and organisation to ensure a common goal: innovative learning.

Experience from the process showed that changing space did not automatically change pedagogical practices. The teachers never really participated in the design process and as a consequence, they did not know the intentions of the space nor how to use it. Based on this, I propose that, ideally, all stakeholders should be involved in the design process from the start-up phase to align teaching, space and organisation. In reality, this might not be possible due to the size of the school, budgets, time, workload and other factors. In this particular case, the teachers did not have time to participate in the design process, a product of the teachers' heavy workloads. To compensate for this, the chapter proposes that the design process should also include a process of activation after implementation of the physical design. In this phase, the users and the designers would work together to activate the new physical frames in relation to pedagogical practices. The purpose would be to match pedagogies with spatial possibilities and to provide the teachers with the necessary skills, tools and resources to change their practices in order to be able to use the space as a pedagogic tool for teaching and learning. The goal would be to help the teachers experience the space as an asset of their pedagogical practices, and not an obstacle. For this to happen, it is necessary to gain more knowledge about the interplay between the physical environment and pedagogical practices in order to create a common language and ways to activate the ILEs.

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References

Beghetto, R. A., & Kaufman, J. C. (2014). Classroom contexts for creativity. *High Ability Studies, 25*(1), 53–69. https://doi.org/10.1080/13598139.2014.905247.

Blackmore, J., Bateman, D., Loughlin, J., O'Mara, J., & Aranda, G. (2011). *Research into the connection between built learning spaces and student outcomes* (0759406642). Retrieved from http://dro.deakin.edu.au/eserv/DU:30036968/blackmore-researchinto-2011.pdf.

Brandt, E., Binder, T., & Sanders, E. B.-N. (2012). Ways to engage telling, making and enacting. In *Routledge international handbook of participatory design* (pp. 145–181). Routledge, New York.

Burke, C. (2016). Quiet stories of educational design. In K. Darian-Smith & J. Willis (Eds.), *Designing schools: Space, place and pedagogy* (pp. 191–204): Routledge.

Byers, T., Imms, W., & Hartnell-Young, E. (2014). Making the case for space: The effect of learning spaces on teaching and learning. *Curriculum and Teaching, 29*(1), 5–19. https://doi.org/10.7459/ct/29.1.02.

Clark, A. (2010). *Transforming children's spaces: Children's and adults' participation in designing learning environments*. Routledge.

Council, D. (2007). *Eleven lessons: Managing design in eleven global companies-desk research report*. Retrieved from http://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_DeskResearchReport_0.pdf.

Craft, A. (2005). *Creativity in schools: Tensions and dilemmas.* USA and Canada: Routledge.

Cropley, A. J. (2001). *Creativity in education & learning: A guide for teachers and educators.* Great Britain: Kogan Page.

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *The Journal of Architecture, 19*(1), 43–63.

Frayling, C. (1993). Research in art and design. In *Royal College of Art Research Papers, 1.*

Higgins, S., Hall, E., Wall, K., Woolner, P., & McCaughey, C. (2005). *The impact of school environments: A literature review*. Retrieved from https://www.ncl.ac.uk/media/wwwnclacuk/cflat/files/impact-school-environments.pdf.

Imms, W., & Byers, T. (2017). Impact of classroom design on teacher pedagogy and student engagement and performance in mathematics. *Learning Environments Research, 20*(1), 139–152. https://doi.org/10.1007/s10984-016-9210-0.

Imms, W., Cleveland, B., & Fisher, K. (2016). Pursuing that elusive knowledge about what works in learning environment design. In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Evaluating learning environments: Snapshots of emerging issues, methods and knowledge* (pp. 3–16). Rotterdam, Netherlands: Sense Publishing.

Imms, W., Mahat, M., Byers, T., & Murphy, D. (2017). *Type and use of innovative learning environments in Australasian schools. ILETC Survey 1* (0734053819). Retrieved from https://minerva-access.unimelb.edu.au/handle/11343/219467.

Jamieson, P., Dane, J., & Lippman, P. (2005). *Moving beyond the classroom: Accommodating the changing pedagogy of higher education.* Paper presented at the Refereed Forum Proceedings of the Australian Association for Institutional Research.

Jamieson, P., Fisher, K., Gilding, T., Taylor, P. G., & Trevitt, A. (2000). Place and space in the design of new learning environments. *Higher Education Research & Development, 19*(2), 221–236. https://doi.org/10.1080/072943600445664.

Kirkeby, I. M. (2006). *Skolen finder sted*. KTH.

Könings, K. D., Bovill, C., & Woolner, P. (2017). Towards an interdisciplinary model of practice for participatory building design in education. *European Journal of Education, 52*(3), 306–317. https://doi.org/10.1111/ejed.12230.

Lackney, J. A. (2008). Teacher environmental competence in elementary school environments. *Children Youth and Environments, 18*(2), 133–159.

Lawson, B. (2006). *How designers think: The design process demystified*. Routledge.

Mahat, M., Bradbeer, C., Byers, T., & Imms, W. (2018). *Innovative learning environments and teacher change defining key concepts—Technical Report 3/2018*. Retrieved from https://minerva-access.unimelb.edu.au/handle/11343/216292.

Mulcahy, D., Cleveland, B., & Aberton, H. (2015). Learning spaces and pedagogic change: Envisioned, enacted and experienced. *Pedagogy, Culture & Society, 23*(4), 575–595. https://doi.org/10.1080/14681366.2015.1055128.

Ricken, W. (2010). *Arkitektur, pædagogik og sundhed.* (PhD). Kunstakademiets Arkitektskole.

Sanders, E., Brandt, E., & Binder, T. (2010). *A framework for organizing the tools and techniques of participatory design.* Paper presented at the Proceedings of the 11th biennial participatory design conference.

Schön, D. (1983). *The reflective practitioner*. Great Britain: Basic Books.

Tanggaard, L. (2014). A situated model of creative learning. *European Educational Research Journal, 13*(1), 107–116. https://doi.org/10.2304/eerj.2014.13.1.107.

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The Enactment of Teacher Collaboration in Innovative Learning Environments: A Case Study of Spatial and Pedagogical Structuration

Chris Bradbeer

Abstract Implicit within the design of many Innovative Learning Environments (ILEs) in New Zealand primary schools is the intention of a group of co-located teachers working together with an 'up-scaled' community of students. To some these socio-spatial settings are suggestive of pedagogical and spatial freedom, of high levels of professional and student agency, and a transformation away from routines established in previous traditional classroom environments. The shift into ILEs may therefore encourage possibilities for novel approaches, the utilisation of individual strengths and opportunities for teachers to determine together how facets of learning, time and space are organised. However, the level of structure required by teams to successfully and collaboratively achieve this presents as a complex, and time-consuming task, with teachers often finding themselves in a space between practicality and potential. This paper draws on observational and interview data from one primary school ILE—part of a wider case study of teacher collaboration in six New Zealand schools. It considers the role of pedagogical and organisational structures alongside levels of autonomy experienced by teachers on adapting to new spaces. The findings indicate that while the occupation and ongoing inhabitation of Innovative Learning Environments may well present opportunities for teachers, tensions may be felt between predominating or created structures, and aspired or idealised practice.

Introduction

The development of Innovative Learning Environments (ILEs) (OECD, 2013) and Flexible Learning Spaces (Ministry of Education, 2011) in New Zealand schools presents a significant shift in educational discourse and school space design. Conceptualised as progressive and relevant socio-spatial assemblages for contemporary approaches to learning and teaching, ILEs and the pedagogical affordances they offer are considered to more readily support diverse requirements of 'twenty-first Century

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learners' than traditional classroom-based environments. Hence, their systematic rollout (Bradbeer et al., 2017) is intended to contribute to the Ministry of Education goals of raising student performance and outcomes (Ministry of Education, 2011, 2016). This alignment of pedagogical intentions with spatial design has resulted in the development of up-scaled primary school spaces containing zones attributed to activities such as presentation, making, collaboration and reflection; as well as settings for both individual and group learning (Dovey & Fisher, 2014; Fisher, 2005).

In the transition into ILEs, it is apparent the spatial and pedagogical shifts required have been demonstrated to demand new competencies of teachers, whether in adopting new pedagogical approaches or in navigating new and up-scaled spaces (see for example Alterator & Deed, 2013; Cleveland, 2011; Cox & Edwards, 2014; Deed & Lesko, 2015; Deed, Lesko, & Lovejoy, 2014; Saltmarsh, Chapman, Campbell, & Drew, 2015; Woolner, Clark, Laing, Thomas, & Tiplady, 2012). Research has drawn attention towards the way that teachers are required to demonstrate adaptability in these situations, and to 'question classroom convention and routine' (Alterator & Deed, 2013 p. 327).

In addition, and notwithstanding the significance of these changes, teachers in ILEs are anticipated to work communally and collaboratively. Identified as leading to a higher degree of pedagogical variation, professional learning and teamwork (OECD, 2013), this mirrors a more general initiative towards engendering higher levels of collaborative professionalism within education and schools. Architecturally this intention is often explicitly articulated; larger spaces designed with larger cohorts of teachers and students in mind, and an absence of individual traditional classrooms where teachers have historically experienced considerable autonomy. Pedagogically though the enactment of effective collaborative practice within ILE appears less well understood. For many teachers it is this aspect of the move into ILE that may constitute the most significant transition on the professional landscape, and one that will entail considerable navigation and negotiation. It is in this space that the present study is situated, with a purpose towards focusing on how one team of teachers conceptualised pedagogical and spatial structures within an ILE.

Teacher Collaboration

The fostering of deeper levels of multilevel collaboration has long been considered instrumental in leveraging large-scale shifts in students' educational outcomes (Fullan & Langworthy, 2014; Goddard, Goddard, & Tschannen-Moran, 2007; Hattie, 2015; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). Much of this success is attributed to the reduction of teacher isolation, increased motivation and morale (Vangrieken, Dochy, Raes, & Kyndt, 2015); in turn leading to higher levels of Collective Teacher Efficacy (Donohoo, 2017; Eells, 2011). However, as Hargreaves and

O'Connor (2017) determined, the level and relative success of collaborative strategies has ebbed and flowed through recent educational history, resulting in the conclusion that, 'not all forms of collaboration are equally strong, desirable, or impactful' (p. 77).

Considered to be a step above situations of cooperation and coordination, collaboration is definitionally concerned with giving something up for the greater good in order to achieve something that is not possible individually (Gray, 1989; Thomson & Perry, 2006). Incumbent within this is a level of formal commitment, planning and organisation towards a commonly held mission, a factor that inherently requires the relinquishment of some individual autonomy and a proportional level of risk to personal reputation (Mattessich, Murray-Close, & Monsey, 2001; Peterson, 1991). Here, and following Hoekstra, Korthagen, Brekelmans, Beijaard, and Imants (2009), autonomy is taken as a degree of control over one's own environment. To successfully accomplish this, the process of collaboration identified by Wood and Gray (1991) outlined a need for shared rules, norms and structures, a clear intention towards action, and a shared orientation towards the purpose that brought people together in the first place. Furthermore as Thomson and Perry (2006) concluded, although the collaborative process required structures in order to make decisions and to manage ways of working, parallel attention to participants' autonomy is needed so that individual identity could be retained, strengths utilised and mutual benefits recognised.

For teachers the literature is unapologetic in arguing that collaboration requires a re-imagining of sometimes long-held teaching identities, a redefining of established 'rules' of teaching, and various degrees of sacrifice of autonomy. An obvious tension therefore surrounding the application of collaborative principles into the context of ILEs is how they might be enacted. That the relative success of an ILE is dependent on strong collaboration between teachers appears obvious, yet its form may present outside many teachers' professional experience.

Furthermore, when examined from a spatial perspective, scenarios of teacher collaboration are often revealed to have taken place outside the classroom with collaboration more usually practiced as a 'visited activity' (Forte & Flores, 2013; McGregor, 2003). More likely, collaborative professional activities have taken place in the staffroom, team meeting or faculty office (McGregor, 2003). In the discourse regarding the transition of teachers into ILEs, the enactment of teacher collaboration from a spatial perspective therefore appears something of an absent presence; it appears underresearched and under-theorised, yet provides a lynchpin underpinning the prospective success of ILEs.

Teacher Collaboration in ILE: The Need for Structure

A consistent theme through the literature on collaboration is the balancing of individual autonomy with structures required to ensure that collaboration works. For many teachers this may present as new learning, in particular when related to concessions of time and space. Historically, within the traditional classroom situation, the establishment and operationalisation of organisational structures such as daily routines, student grouping, time allocation and spatial practices have largely remained under the jurisdiction of relatively autonomous individual professionals (Clandinin & Connelly, 1996). In contrast, and implicit in the move into ILEs, is that team-teaching, sharing of resources, space, distribution of roles and pedagogical organisation will occur (Saltmarsh et al., 2015). Frequently this takes place with larger numbers of students than previously encountered in a classroom setting. For example, Campbell, Saltmarsh, Chapman and Drew (2013) observed a learning environment designed for 75 students and three teachers to note a need for teachers to demonstrate 'willingness to try new things' and to 'take responsibility for their designated tasks' (p. 219). With similar numbers in a high school context Cox and Edwards (2014) observed how timetabling was employed to schedule blocks of subject learning, alongside ability grouping of students; 'this organisation was viewed as a more effective use of the space and more manageable for teaching' (p. 69).

In their case studies Saltmarsh et al. (2015) determined that teachers operating in ILEs appeared to navigate a fine line between the relative levels of structure (or not) in realising responsive pedagogies. They identified a tension between a desired need for innovation and flexibility, alongside the creation of an environment that was ordered enough for learning, that enabled teachers' 'demonstration of professional competence' (p. 324). In their observations they found that 'teaching teams reliant on an over-emphasis on structure and order at times experienced considerable difficulties in achieving the learning goals they had set out' (p. 325). An additional structural tension appears to be in the form of applying previously successful modes of operation into new environments. For Deed and Lesko (2015) although the relative openness of ILEs signified what they refer to as a 'physical and social unwalling of authority and routine' (p. 220) the capacity for teacher adaptation to remain hampered by institutional memory and previously adopted routines remained strong.

In contrast to historically persistent portrayals of classroom teaching as a lonely and isolated profession (Butti, 2016; Lieberman & Miller, 1990; Little, 1990), ILEs represent anything but. The re-scaling of school spaces brought about by the development of ILEs brings teacher collaboration into the front and centre of attention. While a wealth of literature informs challenges and supports the development of collaborative teaching practice, what is noteworthy is the seeming lack of any spatial perspective in this research. For this reason, the case study focuses on describing a set of practices established in a Year 7–8 ILE with a team of three teachers.

The Case Study: Treeside Intermediate

The case study research, part of a wider three-phase Ph.D. study examined the intersection between teacher collaboration and one ILE. The research used a qualitative, collective instrumental case study design (Stake, 1995), so that the issue became the focus rather than the group being studied. Data in this case was collected through observations, semi-structured interviews with the principals and focus groups of teachers and students. It was analysed using thematic narrative analysis (Riessman, 2008), and interrogated through the lens of the theorisation of collaborative process (Thomson & Perry, 2006). The data presented in this paper was gathered from one of the Phase 2 sites, *Treeside Intermediate.*

Treeside Intermediate is a suburban Year 7–8 school built originally in 1976 with a student roll of 290. The school was divided into three 'communities', each occupying a building (recently refurbished on a tight budget), containing a set of rooms (previously individual classrooms), aside from a central 'corridor'. The move into communities had been a relatively recent change prompted by a desire to create a more collaborative teacher culture, and a consideration of how space across the school might be more optimally utilised. The principal reflected that the spatial changes had resulted in a feeling of calmness through the school, and a sense of excitement among teachers to explore what was possible in a new team setting. Within their communities, teams had been given a high level of autonomy to decide how they would operate. Pivotal to the school's vision was the idea of building agency and self-management skills in students, something regularly reinforced through a school-wide set of values. Students were encouraged to take responsibility for their actions, learning and relationships, as well as to feel proud of who they were and what they had achieved.

Findings: Pedagogical, Spatial and Collaborative Practices

The Whio community of learners was home to 94 students. It was staffed by three teachers, (one a 'beginning teacher'), and a teacher aide who worked predominantly with students requiring additional support. At the beginning of the year the teachers acknowledged that they had mainly worked individually with their own 'class', but over the first term had identified ways in which they could work more closely as a team, play to their strengths, and better build levels of self-management with students. They had subsequently divided curriculum responsibilities so that two teachers were responsible for teaching literacy to ability groups across the whole cohort, with the third teaching all the mathematics. Teachers were largely responsible for designing learning and selecting resources for their particular groups. This approach was considered by the team to be pedagogically advantageous as well as a means of creating organisational efficiency. Of concern to teachers under the new structure was over how well they would 'know' individual student's learning across the curriculum, particularly when it came to having conversations with parents. They also noted it reduced their ability to respond spontaneously to learning opportunities and to take more time than had been allocated. However, teachers considered that the new approach had shifted some management emphasis onto the students to ensure they were in the right place at the right time for particular learning groups and activities, something that was supported by a regular routine and reminders in the form of centrally placed timetables. Additionally, this required the students to navigate a structure of spatial usage.

The four rooms adjacent to the central passageway had been named, assigned specific usage and furnished accordingly (see Fig. 1). Room 1 was designated as the *Quiet Space,* and minimally furnished with only a few tables and chairs. In here, 'you can whisper to your buddy, but not loud talking' (Isobel, Year 8). The lack of furniture meant that students often sat on the floor, but it enabled the same room to also function as the larger team meeting space, used particularly to begin the day. Room 2 (*Paired Space*) was allocated for students to work in pairs and was furnished with tall tables and stools. Room 3 was set up as the *Teaching Space,* furnished with a whiteboard on one wall with a set of tables in front of it (for one teacher), and on the other side of the room a teaching station with soft seating around it (for another). In addition, a row of individual desks ran down the outside wall on both sides, facing the front. It was in here that the two teachers teaching literacy or mathematics groups at any one time were based. As one teacher commented: 'The kids know their timetable, and they just come to us. We'll just stay in the room. If we've got two lessons in a row, I'll just sit there all morning and they'll come to me' (Nick, teacher).

Room 4 was referred to as the *Group Space* furnished with tables and chairs designed for small group use. Additionally, a centrally located workspace provided a meeting and storage space for staff. Internal glazing meant there was visibility into Rooms 1 and 2, and to the central passageway. Previously set up as a small science room, teachers and school leaders noted that removing teacher's desks from classrooms and collocating into a shared space had been a deliberate move towards decreasing ownership of space, and the creation of a more collaborative workplace.

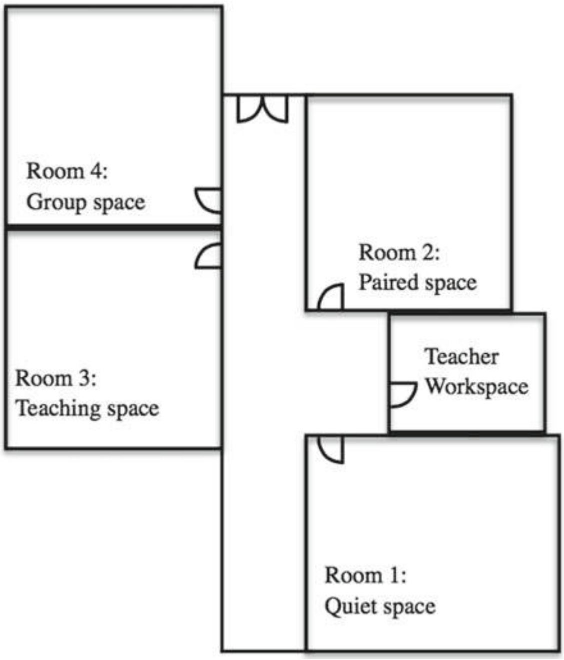

Fig. 1 Spatial layout and designation in 'Whio' community

Teachers viewed it as a key assemblage. It often formed a place for formal and informal meetings during the course of the day. Material evidence of their collegial activities was apparent in a series of Polaroid photographs suspended on a string across the room, these being taken on school trips, during team-building sessions and within the community.

The opportunity for one or two teachers to remain in the *Teaching Space* for any duration was enabled through a set of co-constructed team protocols. Students were assigned activities following maths and literacy sessions that they were expected to complete either individually or with a partner. In addition, a weekly activity sheet contained a number of 'must-do' and 'can-do' tasks. For some students these tasks were differentiated, and support made available from the teacher aide. An established norm within the community was that students knew not to disturb teachers who were engaged working with a group. Instead the expectation was that they would talk to the third teacher, the roaming 'Learning Coach' for assistance. The Learning Coach's role was to respond to queries from individual students, monitor levels of self-management and independence, as well as to 'sign-off' completed activities on the weekly sheet. The practice provided immediacy and timeliness of support that students felt would be lacking if they were all teachers were working with groups simultaneously. As one of the students reflected, 'it's really good because all the time there's a teacher roaming in our block, so you can always ask for help. You're never alone to do your work' (Wiremu, Year 8). Observations distinguished that the Learning Coach's mobility (and that of the teacher aide) was in strong contrast to those teaching in the *Teaching Space.*

For individual students, their opportunity to use the different spaces in *Whio* was determined through a perceived measure of their level of self-management. This was mediated through the 'Independence Wall' and applied the language of SOLO (Structure of Observed Learning Outcomes) taxonomy of learning (Biggs & Collis, 1982) to levels of individual independence. Used primarily across the school as a meta-cognitive framework to describe levels of understanding, teachers in the community had adapted it to this context. Students' positioning on the display board contributed directly to their levels of permissible spatial access. Decided by the teachers, the further to the right their photograph was placed on the display, the greater the range of spaces accessible to them. Consequently, some students were limited to staying in a room with their 'home-room' teacher, while others were able to work away from direct supervision from any teachers, and ultimately to have the freedom to work anywhere through school. During one observation two students moved a small table into the broader central corridor to work together. On noticing, the Learning Coach asked them to move it into the *Quiet Space* instead. Subsequent questioning explained that only one of the students was able to select to learn in any part of the community, hence they had been asked to move. Teachers acknowledged that opportunities for spatial independence provided a level of incentive for many students.

The development of collaborative forms of working (including the use of synchronous and asynchronous online documentation), had formed a significant investment for the team of teachers in *Whio*, including the scaling-up of a number of routines that were required over and above those required by teachers working on their own. Much like Saltmarsh et al. (2015) had identified, the need to spend time together had placed some constraints on teachers. Collaborative decision-making together had been, 'definitely not something you can rush' (Helen, teacher). Planning, and consideration of how the community was going to function on a day-to-day basis had occupied much of their time. Similarly, time dedicated towards meeting each other during the week, to reflect on, and adapt practices to suit their new arrangement was acknowledged as having been considerable and ongoing.

Discussion: Towards Structuration as Enactment of Teacher Collaboration

For the experienced teachers in the study, colocation with colleagues in shared spaces represented a significant departure from their previous spatial experiences within schools. Similarly, for the teacher new to the profession it was appreciably different from the spaces she had trained in and had prepared for. For both, individual classrooms had represented jurisdictional domains, where teachers were relatively free to set structural frameworks (Clandinin & Connelly, 1996). Much as Saltmarsh et al. (2015) had previously concluded, it was evident that there was a high level of organisational sophistication, professional inquiry and collective learning in this shared learning environment that, had teachers been working on their own, would not have been required. In this case much of the need for organisational sophistication appeared concerned with the enactment of teacher collaboration.

Central to the model of collaborative process posited by Thomson and Perry (2006), is the development of structures with which to facilitate decision-making, and reach 'agreement on collaborative activities and goals through shared power arrangements' (p. 24). In this case, through their collaborative process, teachers had created a way of working that would support the enactment of teacher collaboration at the interface with students, and at the same time signalled a shared intention towards action and orientation (Mattessich et al., 2001). Emblematic of 'giving something up for the greater good', and achieving something that was not possible individually (Thomson & Perry, 2006), here the 'greater good' was determined to be a set of values and learning outcomes that could perceivably be better achieved through teachers working in modified spatial settings. In so doing, initial establishment and ongoing maintenance of these through the collaborative process had appeared to require the relinquishment of some individual autonomy (Peterson, 1991). Decisions that teachers might in the past have made about the use of time and space were now negotiated with colleagues. However, the team at *Treeside Intermediate* had been given a high level of decision-making autonomy to develop an approach to achieve what they were ultimately aiming for; the development of student agency and self-management skills. Consequently, teachers considered the resulting limitations to individual professional autonomy as accepted limitations. Furthermore, although teachers expressed the idea that some aspects of their agency were limited by the structures in place, (generally articulated in conjunction with aspects of the curriculum, being able to communicate broad knowledge of individual learners with parents, or capacity to be pedagogically responsive in the face of temporal boundaries), they did not necessarily see it as overly problematic. What they considered they could achieve together outweighed the perceived disadvantages. Data also suggested that the professional culture of inquiry and improvement within the team of teachers also allowed room for ongoing refinement and redesign of practice over time. This is suggestive of Hargreaves and O'Connor's (2017) reflection that collaborative cultures were characterised by trust, openness about problems, independence, collective effort and shared responsibility. In time, perceived limitations could and might be addressed.

The team of teachers in *Whio community* had developed an assemblage of temporal and spatial structures that deliberately articulated and reinforced organisational routines and pedagogical practices. Routines to encourage both agency and self-management were operationalised and accomplished within boundaries of behaviour and well-defined parameters. Teachers' use of time and space was strongly governed by those parameters and included limits on time spent with student groups, the requirement to adhere to timetables and responsibilities, and the need to meet regularly to collectively make decisions. Additionally, teacher spatial mobility depended on the role they were playing; in turn the level of mobility they permitted students was similarly dependent on an additional structural framework. Taken together, these structures were viewed as means to enact both school-wide intentions, conceptualised in terms of developing levels of learner agency and self-management, and to respond to the needs of the current cohort of students. In addition, they were considered by participants to support the transition of teachers and students to new ways of working. Specifically, the practices and structures teachers employed also ensured that they maintained a level of control over a larger cohort of students while at the same time theoretically providing room to develop more self-managing skills among them. Here there appears a fine line between agency, self-management and the requirements for structures in 'amplified' (Alterator, 2015) environments, that may in turn conjure images of Foucaultian control mechanisms. Justification for this was connected with the idea that intermediate schools are '80-week schools' (Principal), and that there is a need for the quick establishment of expectations and routines. A useful next research step could be in understanding the type of agency afforded in *Whio community* in conjunction with the school's idealised vision. Engagement with a recent case study by Charteris and Smardon (2017) could assist in creating a more granular perspective of the agency afforded: sovereign, relational, ecological or new material (Charteris & Smardon, 2017).

Analysis of the structures that were evident in the *Whio community* teachers' joint work suggested classification into three broad categories: structures that existed beforehand, structures that didn't and those that existed beforehand but required modification. The former could perhaps be termed *Heritage structures* in that they had been carried across over time (and space). In this category they were seen to include a language of educational values and vision common across the school, the practice of timetabling subjects, the allocation of students to a specific 'home-room' teacher. *Modified structures* included the use of ability groups (now shared between more than one teacher), the utilisation of SOLO taxonomy (used in an alternate context) and the removal of individual teacher desks (into a shared space). *Novel structures* were seen to include the practice of the 'roaming' Learning Coach, the use of synchronous and asynchronous collaborative teacher documentation, and the relationship between self-management levels and individual spatial access.

In considering organisational and pedagogical structures encountered in the case study it is important not to view them necessarily as imposed, immovable and forming a barrier between what the teachers idealised as desirable student outcomes (increased independence and self-management), and what they found themselves doing. Conspicuously it was the team of teachers themselves who had instigated particular ways of working and the structures that would enable them to do so, rather than them being externally dictated. The resultant structures had therefore largely emerged from the collaborative process itself; some replicating existing practices, some modified versions of what had gone before and others, in this context, new. As an example, the reflexive relationship between learning space and the assemblage of structures presented as pertinent in supporting the enactment of collaborative practices. Spaces and activities were articulated as mutually associated. The usage has been decided by the teachers according to levels of group size, requirements for adult intervention or supervision, and preferred levels of visibility and sound. The resultant typology had become a pedagogical structure that determined which students (and sometimes which teachers), could occupy particular spaces, and under what conditions they could do so. Explicit naming or referencing the spatial typology offered teachers and students a shared language within *Whio* that both were expected to adhere to.

Structure and agency have often been portrayed as opposite ends of a continuum, perhaps because simplification and binary thinking often offer a means of more simply comprehending the world we live in (Cloke & Johnston, 2005; Gregson, 2005). For social theorist Giddens (1984) however, structure, and its relationship, particularly with agency, is considered less of a dualism and more of a duality. He warns against visualising 'structure' as external to human action, 'akin to the skeleton or morphology of an organism or to the girders of a building' (p. 16). Instead he considers that structure is 'both constraining and enabling' (p. 25) and necessarily co-constitutive. His theory of structuration holds that through their existing structures allow and enable behaviour, and so too, behaviour can potentially influence and modify structures. The infinitely cyclical manner through which this is seen to occur is described as structuration, a process that according to Archer (1982) never reaches an endpoint, and only momentarily a product. With structuration used to describe the interplay between structure and agency, formation and deformation, it echoes the notion of 'serial re-design' used by Thomson and Blackmore (2006) to describe ongoing improvement in schools.

As a theoretical framework, structuration appears to hold a useful role in professional learning regarding the enactment of teacher collaboration in ILEs. It presents as three-fold. Initially, in articulating multifarious forms of structure, be they temporal, spatial, organisational or linguistic. Their role when working with multiple adults and a larger cohort of students appears vital to the establishment and ongoing navigation of pedagogical approaches for both teachers and students. Secondly, there is space to incorporate, modify or innovate on existing structures, and to adapt, modify and redesign on an ongoing basis as required. Thirdly, that by viewing structures as enabling rather than constraining, their utilisation may foster approaches that leverage practices rather than limit them. Collectively these seem a useful framework to consider aspects of teachers' collaborative work as they undertake a transition from familiar to less familiar teaching and learning environments. It also responds to the theme that although much has been made of the potential of teacher collaboration in education, research detailing its enactment and reification in ILEs rather than in conceptual or theoretical form remains elusive, and a significant space for researchers to work within.

Conclusion

The requirement to work collaboratively in ILEs presents teachers with new challenges. Many stem from the need to develop pedagogical and organisational practices consistent with a team approach and larger cohort of students, rather than those previously utilised in traditional single teacher classroom settings. Determining how learning is articulated and enacted, the way space and time are navigated, and mechanisms for enabling consistency, continuity and communication, form decisional components that first create structure, and then support enactment. However, structures may both encourage as well as prevent subsequent practices. In the case illustrated here the structures designed to promote learning, self-management and agency, were considered by teachers to meet the needs of students and the vision of the school. However, the self-same structures viewed through a structure/agency dualism lens were also observed to create tensions in the way they limited the use of both time and space for teachers and students alike. As teams of teachers in ILEs develop increasingly sophisticated approaches towards teaching and learning in ILEs, structuration theory may provide a beneficial lens through which to examine the balance between levels of structure required to foster successful collaboration, and that of maintaining desirable levels of individual autonomy.

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References

Alterator, S. (2015). *What are sustainable or generative teacher skill sets in teaching and learning within open plan learning environments?* Ph.D. thesis. School of Education. La Trobe University, Bundoora, Victoria.

Alterator, S., & Deed, C. (2013). Teacher adaptation to open learning spaces. *Issues in Educational Research, 23*(3), 315–330.

Archer, M. S. (1982). Morphogenesis versus structuration: On combining structure and action. *The British Journal of Sociology* (4), 455–483. https://doi.org/10.2307/589357.

Biggs, J. B., & Collis, K. F. (1982). *Evaluating the quality of learning: The SOLO taxonomy (Structure of the Observed Learning Outcome).* New York: Academic Press.

Bradbeer, C., Byers, T., Cleveland, B., Kvan, T., Mahat, M., & Imms, W. (2017). The 'state of play' concerning New Zealand's transition to innovative learning environments: Preliminary results from phase one of the ILETC project. *Journal of Educational Leadership Policy and Practice, 32*(1), 22–38.

Butti, L. (2016). Professional relationships: Collaboration is key. *The English Journal, 105*(3), 12–15.

Campbell, M., Saltmarsh, S., Chapman, A., & Drew, C. (2013). Issues of teacher professional learning within 'non-traditional' classroom environments. *Improving Schools, 16*(3), 209–222. https://doi.org/10.1177/1365480213501057.

Charteris, J., & Smardon, D. (2017). A typology of agency in new generation learning environments: Emerging relational, ecological and new material considerations. *Pedagogy, Culture & Society, 26*(1), 51–68. https://doi.org/10.1080/14681366.2017.1345975.

Clandinin, D. J., & Connelly, F. M. (1996). Teachers' professional knowledge landscapes: Teacher stories-stories of teachers-school stories-stories of schools. *Educational Researcher, 25*(3), 24–30. https://doi.org/10.3102/0013189x025003024.

Cleveland, B. (2011). *Engaging spaces: Innovative learning environments, pedagogies and student engagement in the middle years of school*. Ph.D. Unpublished, Melbourne University, Melbourne.

Cloke, P., & Johnston, R. (2005). Deconstructing human geography's binaries. In P. Cloke & R. Johnston (Eds.), *Spaces of geographical thought*. London: SAGE.

Cox, P., & Edwards, D. (2014). Restructuring teaching and learning in open-plan schools. In V. Prain, P. Cox, C. Deed, D. Edwards, C. Farrelly, M. Keefe, V. Lovejoy, L. Mow, P. Sellings, B. Waldrip, & Z. Yager (Eds.), *Adapting to teaching and learning in open-plan schools* (pp. 61–78). Rotterdam: Sense.

Deed, C., & Lesko, T. (2015). 'Unwalling' the classroom: Teacher reaction and adaptation. *Learning Environments Research* (18), 217–231. https://doi.org/10.1007/s10984-015-9181-6.

Deed, C., Lesko, T., & Lovejoy, V. (2014). Teacher adaptation to personalized learning spaces. *Teacher Development, 18*(3), 369–383. https://doi.org/10.1080/13664530.2014.919345.

Donohoo, J. (2017). Collective teacher efficacy research: Implications for professional learning. *Journal of Professional Capital and Community, 2*(2), 101–116. https://doi.org/10.1108/JPCC-10-2016-0027.

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *The Journal of Architecture, 19*(1), 43–63.

Eells, R. J. (2011). *Meta-analysis of the relationship between collective teacher efficacy and student achievement*. Ph.D., Loyola University, Chicago. Retrieved from http://ecommons.luc.edu/luc_diss/133.

Fisher, K. (2005). Linking pedagogy and space: Proposed planning principles. Retrieved from http://www.eduweb.vic.gov.au/edulibrary/public/assetman/bf/Linking_Pedagogy_and_Space.pdf.

Forte, A. M., & Flores, M. A. (2013). Teacher collaboration and professional development in the workplace: A study of Portuguese teachers. *European Journal of Teacher Education, 37*(1), 91–105. https://doi.org/10.1080/02619768.2013.763791.

Fullan, M., & Langworthy, M. (2014). A rich seam: How new pedagogies find deep learning. Retrieved from http://www.michaelfullan.ca/wp-content/uploads/2014/01/3897.Rich_Seam_web.pdf.

Giddens, A. (1984). *The constitution of society*. Cambridge: Polity.

Goddard, Y., L., Goddard, R., D., & Tschannen-Moran, M. (2007). A theoretical and empirical investigation of teacher collaboration for school improvement and student achievement in public elementary schools. *Teachers College Record, 109*(4), 877–896.

Gray, B. (1989). *Collaborating: Finding common ground for multiparty problems*. San Francisco: Jossey-Bass.

Gregson, N. (2005). Agency: Structure. In P. Cloke & R. Johnston (Eds.), *Spaces of geographical thought*. London: Sage.

Hargreaves, A., & O'Connor, M. T. (2017). Cultures of professional collaboration: Their origins and opponents. *Journal of Professional Capital and Community, 2*(2), 74–85. https://doi.org/10.1108/JPCC-02-2017-0004.

Hattie, J. (2015). *What works best in education: The politics of collaborative expertise*. Retrieved from https://www.pearson.com/hattie/solutions.html.

Hoekstra, A., Korthagen, F., Brekelmans, M., Beijaard, D., & Imants, J. (2009). Experienced teachers' informal workplace learning and perceptions of workplace conditions. *Journal of workplace learning, 21*(4), 276–298. https://doi.org/10.1108/13665620910954193.

Lieberman, A., & Miller, L. (1990). The social realities of teaching. In A. Lieberman (Ed.), *Schools as collaborative cultures: Creating the future now*. New York: The Falmer Press.

Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record, 91*(4), 509–536.

Mattessich, P. W., Murray-Close, M., & Monsey, B. R. (2001). *Collaboration: What makes it work. A review of research literature on factors influencing successful collaboration* (2nd ed.). Saint Paul, MN: Fieldstone Alliance.

McGregor, J. (2003). Making spaces: Teacher workplace topologies. *Pedagogy, Culture & Society, 11*(3), 353–377. https://doi.org/10.1080/14681360300200179.

Ministry of Education. (2011). *The New Zealand school property strategy 2011–2021*. Retrieved from http://www.minedu.govt.nz/NZEducation/EducationPolicies/Schools/SchoolOperations/~/media/MinEdu/Files/EducationSectors/PrimarySecondary/PropertyToolbox/StateSchools/SchoolPropertyStrategy201121.pdf.

Ministry of Education. (2016). *The impact of physical design on student outcomes*. Retrieved from http://www.education.govt.nz/assets/Documents/Primary-Secondary/Property/School-property-design/Flexible-learning-spaces/FLS-The-impact-of-physical-design-on-student-outcomes.pdf.

OECD. (2013). Innovative learning environments. *Educational Research and Innovation*. https://doi.org/10.1787/9789264203488-en.

Peterson, N. L. (1991). Interagency collaboration under Part H: The key to comprehensive, multidisciplinary, coordinated infant/toddler intervention services. *Journal of Early Intervention, 15*(1), 89–105.

Riessman, C. K. (2008). *Narrative methods for the human sciences*. Thousand Oaks, CA: Sage.

Saltmarsh, S., Chapman, A., Campbell, M., & Drew, C. (2015). Putting "structure within the space": Spatially un/responsive pedagogic practices in open-plan learning environments. *Educational Review, 67*(3), 315–327. https://doi.org/10.1080/00131911.2014.924482.

Stake, R. E. (1995). *The art of case study*. Thousand Oaks: Sage.

Stoll, L., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7*(4), 221–258.

Thomson, P., & Blackmore, J. (2006). Beyond the power of one: Redesigning the work of school principals. *Journal of Educational Change, 7,* 161–177. https://doi.org/10.1007/s10833-006-0003-6.

Thomson, A. M., & Perry, J. L. (2006). Collaboration processes: Inside the black box. *Public Administration Review, 20,* 20–32. https://doi.org/10.1111/j.1540-6210.2006.00663.x.

Vangrieken, K., Dochy, F., Raes, E., & Kyndt, E. (2015). Teacher collaboration: A systematic review. *Educational Research Review, 15,* 17–40. https://doi.org/10.1016/j.edurev.2015.04.002.
Wood, D. J., & Gray, B. (1991). Toward a comprehensive theory of collaboration. *The Journal of Applied Behavioral Science, 27*(2), 139–162. https://doi.org/10.1177/0021886391272001.
Woolner, P., Clark, J., Laing, K., Thomas, U., & Tiplady, L. (2012). Changing spaces: Preparing students and teachers for a new learning environment. *Children Youth and Environments, 22*(1), 52–74.

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School Change: Emerging Findings of How to Achieve the "Buzz"

Raechel French

Abstract This chapter explores emerging findings from the research question, "What characterizes a successful transition of a school from traditional classrooms to an innovative learning environment in the context of the design and construction process?" Many schools today are trading in their identical classroom model for activity-driven, technology-infused spaces and envision a future in which teaching, culture, and space align seamlessly resulting in the intangible "buzz" of engaged learning. However, research and experience show many of these schools fail to supplement the design and construction process with initiatives to align teaching practices, organizational structures, and leadership with the intended vision. This often results in a misalignment between the pedagogical goals of the building and its subsequent use. To provide a research-based course of action for transitioning schools and a basis for future Ph.D. study, exploratory case studies were completed of schools operating in new buildings and having achieved this "buzz". Emerging best-practice processes and tools are shared.

Introduction

Alignment of School Design and Use

When categorizing spaces by the alignment of pedagogy and design intent, four scenarios emerge (Fig. 1). One represents the "*status quo*" in which teachers teach with predominantly direct instruction in a school with a traditional design (for example, double-loaded corridor, identical classrooms, rows of desks facing a teaching wall). The reverse of this is what this chapter deems "*the buzz*" in which teaching is predominantly student-led and multi-modal in a school with an innovative learning environment design, or ILE (defined as being multi-modal, activity-based, and technology-infused). There is also the "*square peg, round hole*" scenario in which

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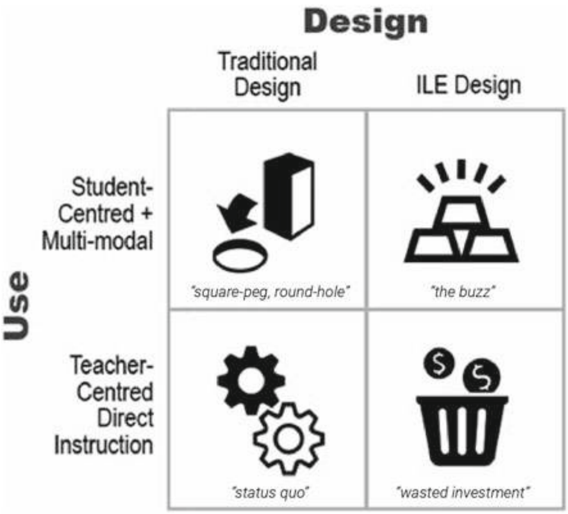

Fig. 1 Matrix of alignment and misalignment between the design and use of schools

there is student-led teaching and learning occurring in a traditional space and the "*wasted investment*" scenario in which there is an ILE design but still predominantly teacher-led, direct instruction.

Many schools end up in this "*wasted investment*" quadrant when they invest in new spaces but do not invest in developing new teaching and organizational practices (Saltmarsh, Chapman, Campbell, & Drew, 2015). Through case studies answering the question, "What characterizes a successful transition of a school from traditional classrooms to an innovative learning environment in the context of the design and construction process?" this research seeks to identify strategies to help schools and teachers transition from the "*status quo*" to "*the buzz*" while avoiding "*wasted investment*".

Literature Review

When considering the transition into new spaces, the literature often focuses on the design with little regard for the "implementation and transition phase" (Blackmore, Bateman, O'Mara, & O'Loughlin, 2011). Blackmore et al. (2011) identified seven areas requiring further inquiry, three of which will be addressed through the Ph.D. research of which this chapter is the first step: "the processes and preparation required to transition…the types of practices that emerge in new spaces…(and) the organisational cultures and leadership that facilitate or impede innovative pedagogies" (Blackmore et al., 2011, p. v). Teaching and learning often remain traditional and explicit despite inhabiting new space types with broader teaching and learning potential (Saltmarsh et al., 2015). This is anticipated to be due to lack of focus on organizational structures, leadership, relationships, and/or teacher professional development. Previous research completed on school design often ignores these factors while literature on whole school change often ignores the impacts of school design.

It is important to note that this research does not focus on the design of space itself nor its impact on teaching and learning. Research here is well covered and ongoing (Barrett, Davies, Zhang, & Barrett, 2015; Blackmore et al. 2011; Cleveland & Fisher, 2014; HEFCE, 2006). Instead, this chapter operates under the assumption that the design team has created a space that, if used as intended, has the potential to function properly in regard to pedagogy, acoustics, technology, air quality, and lighting, among others. The focus instead is on the transition process implemented to shift the school organization and support educators to align their practices with the intended functions of the new space.

Research Design

The research question, "What characterizes a successful transition of a school from traditional classrooms to an innovative learning environment in the context of the design and construction process?" aligns with Yin's (2014) scope of a case study in that the phenomenon of school transitions is a contemporary, real-world phenomenon highly impacted by its organizational, social, and political contexts. Further, the features of a case study apply in that multiple variables (rather, the characteristics of the transition) overlap and thus, multiple sources of evidence connected through theoretical basis are required to properly triangulate data and come to valid conclusions. The research process was both reflective with examination of the previous design and transition process and real-time with examination of the ongoing transitional efforts being made in the early years of occupying the school.

The unit of analysis is the entire school or in the case in which only part of the school was redesigned, the portion of the school residing in new space. The teachers are an embedded unit of analysis. The transition process includes, but is not limited to, the following elements: leadership; professional development; educator perceptions; presence and type of students; teacher, stakeholder, and community engagement; and, strategic messaging. The initial bounds were fluid due to the exploratory nature of the case studies.

Site Selection

To successfully answer the research question, participating schools must have (1) a new[1] ILE design; (2) been initially staffed with teachers used to teaching in traditional settings; (3) an indication that it is operating as intended or on track to do so (rather, on track to achieve "*the buzz*"); and (4) the ability to provide access to documentation of the design and transition process. For the research and analysis to remain feasible within the ten-month timeline of the Fulbright scholarship program, case study sites were limited to four. Case study sites were selected by applying these requirements to data collected through a survey conducted by the Innovative Learning Environments and Teacher Change (ILETC) research project led by the Learning Environments Applied Research Network from The University of Melbourne (Imms, Mahat, Byers, & Murphy, 2017). The main research question of the ILETC is "Can altering teacher mind frames unlock the potential of innovative learning environments?" (ILETC, 2016). A central component of this research is the relationship between types of learning environments, teaching practices, teacher mind frames, and student deep learning (Imms et al., 2017).

The ILETC survey was completed by 822 school principals and/or leaders throughout Australia and New Zealand. The survey classified the school's physical environment design and measured its teacher mind frames, the presence of student deep learning, and teaching approaches, among other items (Imms et al., 2017). ILE design was determined by respondents indicating a learning space type of C, D, or E[2] from Dovey and Fisher's spatial typologies (2014). Case studies with likely successful operations were identified as those scored with above-average ratings for teacher mind frames and student deep learning and having a predominantly student-centred teaching approach. An internet search on schools fitting the criteria was completed to rule out schools not residing in new facilities. A subsequent telephone census was conducted with schools passing the internet search to identify if teachers had come from traditional settings, that documentation of the design and transition process was feasible, and confirm willingness to participate as a case study site. Schools were approached for participation in descending order of their teacher mind frame scores.

The first four schools that passed the telephone census and expressed willingness to participate were selected for case studies, one of which contained multiple, separate ILE sites. Two of the schools were located in Australia and two in New Zealand. One was a Catholic school and the others were government schools. They support communities of varying levels of socio-economic backgrounds and were all at different points of their transition with some more established than others.

[1]Two of the case study sites were within their first 2 years of occupation. One opened in 2011 and another in 2009. Participants in the older school were involved prior to opening and the design and transition process was well documented.

[2]Type C—Traditional classrooms with flexible walls and breakout space; Type D—Open plan with the ability for separate classrooms; Type E—Open plan with some adjoining spaces.

Some were brand new schools to support population growth and others replaced existing facilities. Regardless, all schools were trying to take teachers from traditional teaching in traditional facilities to successfully inhabit an innovative learning environment.

Methods

Participants from each case study site included teachers, school leaders, and school designers. A total of 20 teachers, 4 school leaders, and 3 designers have participated in the study. Teachers participated in a focus group consisting of a transition game, the creation of a Journey Map, and completion of a letter written to a future teacher transitioning to an ILE. This focus group format was developed through workshops as part of the ILETC and tested through a pilot study at a school in Victoria, Australia. Images of these tools can be found in Figs. 2 and 3. Teachers also participated in a one-on-one interview following the focus group. School leaders participated in an interview and led a tour of the school. School designers, which encompass architects and/or educational planners or members of the establishment board, participated in an interview.

This chapter represents initial thematic analysis from the interviews and focus groups. Interviews and focus groups were transcribed by the researcher and inputted into Nvivo qualitative analysis software. A grounded theory approach was taken. The first step involved the assignment of one or more codes to each data point in the transcripts. These codes evolved from the data and were not pre-determined. As new codes were created throughout the process, the second round of coding was completed to ensure that all transcripts benefited from the full set of codes. These codes were then aggregated into broader themes and finally organized into the three broad categories, discussed later in this paper. Figure 4 indicates one example of the coding process followed by the researcher, using the example of Organizational Enablers. Indicative quotes are provided along with initial codes and their alignment to the final themes. It is anticipated that further theoretical sampling will be undertaken along with follow-up interviews and supplemental data collection.

Defining the "Buzz"

Defining success is not a goal of this research. Instead, this research sought to understand the alignment between what the school wished to see as success and the subsequent reality of the space and its use. Thus, one of the questions asked of all research participants at the four selected case study sites was how they personally define success in their new spaces. Deduced from the data was the concept of "the buzz" or rather, the palpable presence of student-driven, engaged learning. The following interview quotes are indicative of the conversation at all four schools around the definition of success in an ILE.

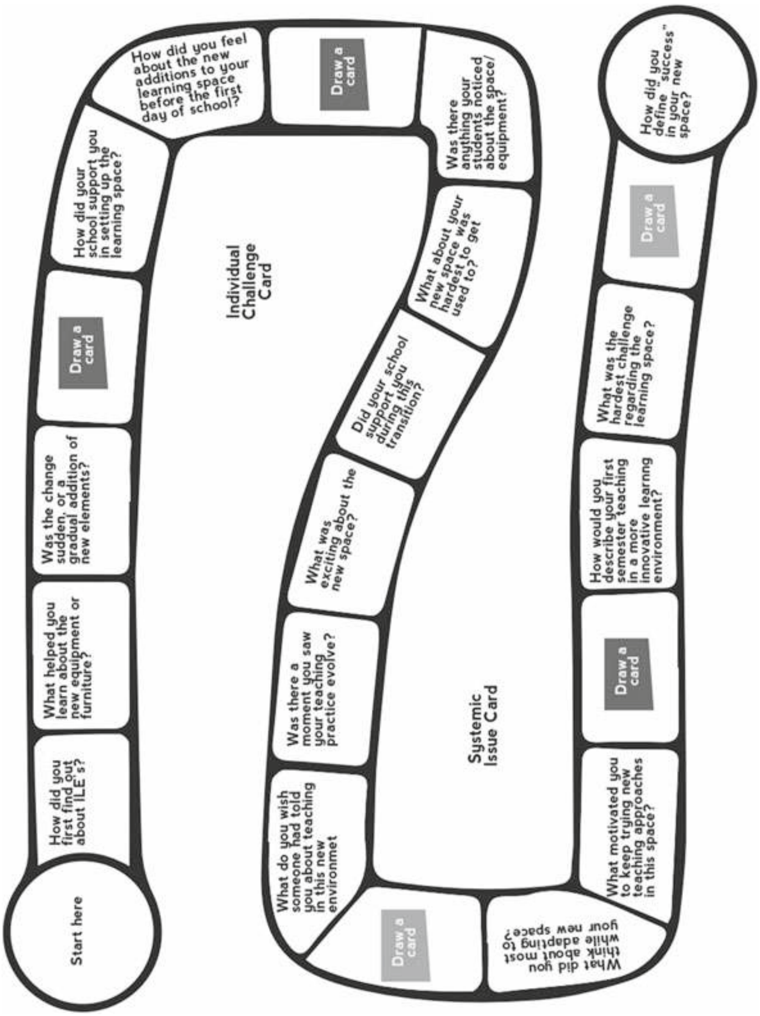

Fig. 2 Transition game

…it's the start of the unit where they're going off and doing a bit of searching about something they're interested in—there's a real buzz in the room and I think that's a sign of success

The measure of success is in how it "just works". Sometimes it's not tangible. But the place is always alive and buzzing…I see a really cohesive group of people working together for the benefit of the students and that's, that is tangible.

It's like an idling engine so it kinda just hums along and (teachers) don't have to be there for it to go like that but when (they) want it to accelerate then that's where (teachers) come in.

(success is) that one on one individual, moving around…it's the hum of learning together and discussing and you think, where's the teacher?!

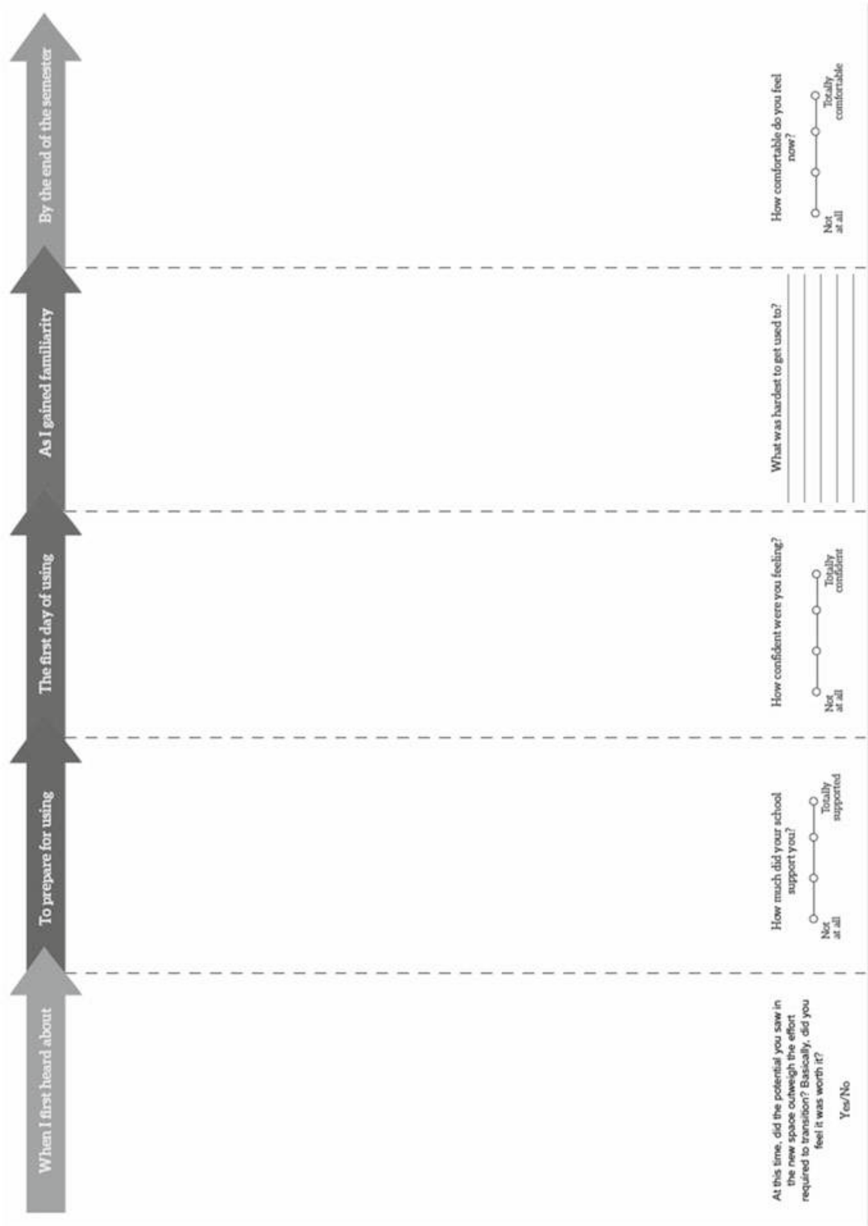

Fig. 3 Journey map

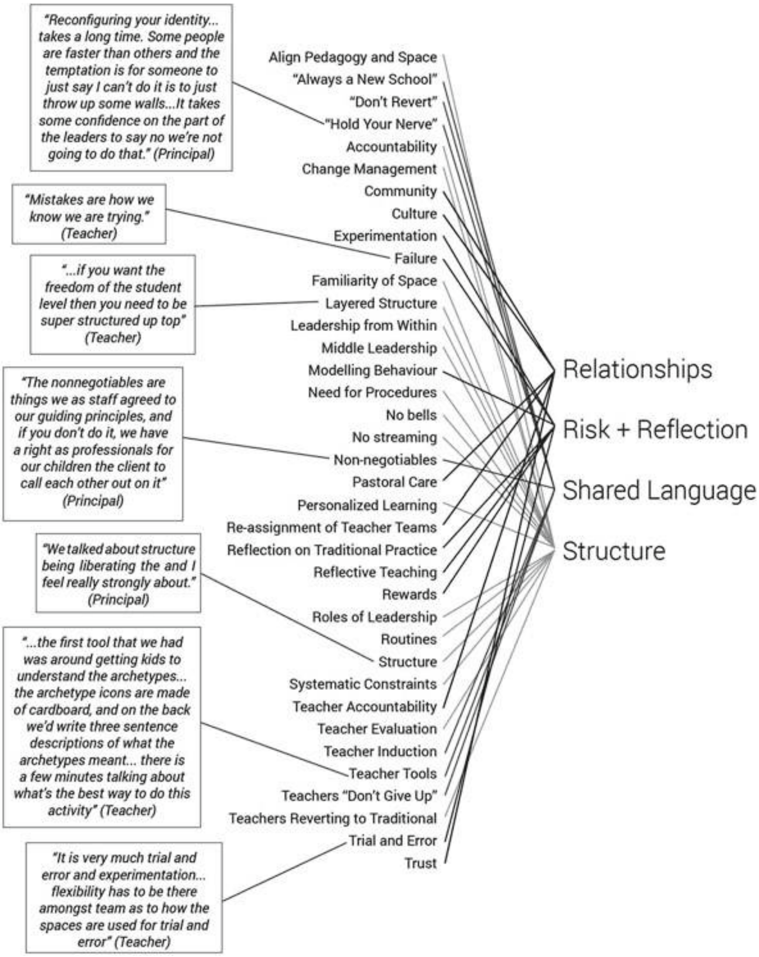

Fig. 4 Coding and quote examples—Organizational enablers

The "*buzz*" is not a prescriptive term, yet it elicits clear understanding regarding what expectations and activities underlie the word. It also lends itself as being broad enough to encompass an array of pedagogical goals of a school. Many things can result in the "*buzz*"; it is not created through the building itself but in the inhabitation of the facility and its corresponding culture, leadership, organizational structures, and teacher mindsets that coincide.

Emerging Themes

This paper reflects findings from early stages of analysis of exploratory case studies. At the moment, themes are aligning into three categories: pre-occupation enablers which are steps schools took before moving into their new facilities, organizational enablers which represent the ongoing cultural, leadership, and structural variables, and spatial enablers which are moments in which the spatial design itself plays a key role in helping teachers and students shift their practice. It should be noted that there are few clean breaks between themes. They interrelate with one another as the pre-occupation steps help set the stage for the culture to take hold or the space to have the leverage required. Further, their effectiveness depends on many moderating factors. Unpacking this process will occur through future Ph.D. research.

Pre-occupation Enablers included prototyping space and pedagogy, forming clarity around the purpose of the spatial design, and indoctrinating the "why" of the design through research. Organizational Enablers included establishing and embedding a shared language; focusing on relationships between teachers, between teachers and students, and between students themselves; maintaining a culture of risk; and purposeful structure across each level of the organization. The latter is what this chapter is calling "layered scaffolding" and is explored in more detail below. Spatial enablers included transparency and openness allowing for visible teaching, ongoing authentic observation, and implicit student behaviour management. The sense that spatial inflexibility could 'nudge' a teacher to shift pedagogically also arose from the data. Figure 4 uses the example of Organizational Enablers to provide indicative quotes and show initial codes and their alignment with the eventual themes.

An Example Strategy: Layered Scaffolding

All case study sites utilized an ongoing process this chapter calls "Layered Scaffolding". This is the notion of providing the ideal amount of structure at each layer of the organization so that the level below experiences "just enough" guidance to allow innovation to flourish. The government level, which may be the Department/Ministry of Education or the establishment board, provided structure over which the principal was appointed and mandated to innovate. This may be the school design itself and/or a prescribed pedagogical direction, among other possibilities. The principal and other school leaders establish timetables, evaluation metrics, or other non-negotiables that align with this vision and provide a basis through which educators can have autonomy over their courses. These educators then establish routines for students or leverage purposeful relationships to guide student behaviour and allow appropriate amount of choice and self-regulation in their learning. One school leader interviewed summed this concept up well by saying "If you want the freedom at the student level then you need to be super structured up top".

In schools or learning spaces in which such scaffolding was not done, or structure was not provided, teachers created their own which would trend towards the traditional. This concept aligns with other recent work on structuration in which teachers, when perceiving a lack of order, imposed their own inflexible spatial practices and didn't make best use of either the space or materials. "Teachers see the imposition of (their own) additional structuring of both lessons and the daily timetable as the most appropriate pedagogic response to what they perceive as a lack of order" (Saltmarsh, et al., 2015, p. 322).

One example of such "layered scaffolding" is a strategy employed by one of the schools to assist teachers in modifying their pedagogy. This principal, when preparing teachers to inhabit a school with a prescribed vision of team teaching and spaces with flexible, non-traditional furniture developed a series of expectations for educators through the language of David Thornburg's archetypes (Thornburg, 2001, revised 2007). These archetypes compare learning spaces to campfires, watering holes, caves, and the like and provide a shared language for space. The archetypes were then used as part of educators' cultural and spatial induction. They were incorporated into teachers' lesson planning, ongoing classroom management, and teachers' own evaluation. With the expectation of their students sharing this language as well, some teachers created tangible icons, manipulatives, and displays. The discussions of space were thus ingrained in the daily operations and routines and became effective proxies for the envisioned pedagogy and student behaviour. For example, students knew that when they were in a "Watering hole" they should not just be socializing but sharing knowledge. Teachers as well were being challenged by leadership to reduce their "Campfire" time which effectively guided them from less lecture to more student-centred instruction. This use of archetypes as structure was effectively change management in disguise.

This strategy aligns with recent work on the sociomaterial view on the inhabitation of space in which "New school buildings matter…as effects of materializing processes in which school personnel and objects take part. The building gives the principal above 'licence…to ask those bigger questions' and to 'crowbar' the process of curriculum and pedagogic change" (Mulcahy, Cleveland, & Aberton, 2015, p. 10). The space is linked to text, technology, and artefacts in a circulatory fashion as pedagogic change and spatial change come to being together.

Next Steps and Future Application

The themes and examples presented here reflect early findings from initial thematic analysis and form the basis for further exploration. For example, the body of knowledge can be extended by broadening the suite of case studies beyond Australia and New Zealand and developing more in-depth analysis linking these to the original case studies. The highlighted example of "Layered Structuring" can be deepened, exploring both the relationship between the concentric layers of structure and identifying specific tools and strategies to be applied in each. The three categories of enablers can also be unpacked, each containing multiple specific strategies and tools, only one of which was highlighted in this chapter, that can inform future school design and transition processes. Another trajectory may be the refinement of these enablers and exploration of their relationships to one another to propose a systems-based approach to the school transition process.

While all of these proposed directions, among others, are feasible, it is desired that the next step for this research does focus on the applicability of this burgeoning knowledge. One opportunity is aligning with Phase 2 and 3 of the ongoing ILETC research in which tools and strategies to support the teacher transition process will be piloted and then disseminated at scale to test their efficacy (ILETC, 2016). This research focus is especially suited to the creation of tools to be applied alongside the design process of the ILE, leveraging most intensely the often-under-utilized period during construction to assist with the forthcoming educational transition. When done right, the goal is for schools to find their “buzz” sooner, rather than later.

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References

Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils’ learning: Final results of a holistic, multi-level analysis. *Building and Environment, 89,* 118–133.

Biggs, J. B. (1987). *Student approaches to learning and studying. Research monograph.* Hawthorn: Australian Council for Educational Research.

Blackmore, J., Bateman, D., O’Mara, J., & O’Loughlin, J. (2011). *Research into the connection between built learning spaces and student outcomes: Literature review*. Victoria, Australia: Victorian Department of Education and Early Childhood Development.

Cleveland, B., & Fisher, K. (2014). The evaluation of physical learning environments: A critical review of the literature. *Learning Environments Research, 17,* 1–28.

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *The Journal of Architecture, 19*(1), 43–63.

HEFCE. (2006). *Designing spaces for effective learning*. UK: Higher Education Funding Council for England.

ILETC. (2016). *Can altering teacher mind frames unlock the potential of innovative learning environments?* Retrieved from https://www.flipsnack.com/iletc/flyerlayoutwebv1.html.

Imms, W., Mahat, M., Byers, T., & Murphy, D. (2017). *Type and use of innovative learning environments in australasian schools.* ILETC Survey No. 1, University of Melbourne, Melbourne. LEaRN, Retrieved from http://www.iletc.com.au/publications/reports/.

Mulcahy, D., Cleveland, B., & Aberton, H. (2015). Learning spaces and pedagogic change: envisioned, enacted and experienced. *Pedagogy, Culture & Society.* https://doi.org/10.1080/14681366.2015.1055128.

Saltmarsh, S., Chapman, A., Campbell, M., & Drew, C. (2015). Putting “structure” within the space”: Spatially un/responsive pedagogic practices in open-plan learning environments. *Educational Review, 67*(3), 315–327. https://doi.org/10.1080/00131911.2014.924482.

Thornburg, D. (2001, revised 2007) *Campfires in cyberspace: Primordial metaphors for learning in the 21st century*. Ed at a Distance 15(6). Retrieved from https://www.nsd.org/cms/lib/WA0

1918953/Centricity/Domain/87/TLC%20Documents/Other%20TLC%20Documents/CampfiresInCyberspace.pdf.
Yin, R. (2014). *Case study research: Design and methods*. Los Angeles: Sage.

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Increasing Teacher Engagement in Innovative Learning Environments: Understanding the Effects of Perceptions of Risk

Tamara K. Jones and Deidre M. Le Fevre

Abstract School systems around the world are investing in a transition to Innovative Learning Environments (ILEs). Many policies and resources are being directed towards this change. However, if the effects of innovative educational initiatives are to be positive for our students, the onus will ultimately be on teachers to integrate learner-centric pedagogies and digital technologies in flexible learning environments. Educational innovations are dependent upon what teachers think, feel and do in classrooms (Fullan 2001). This chapter examines how teacher perceptions can influence their engagement in ILEs.

Internationally, many education policies are promoting ILEs as a way of better meeting the needs of twenty-first-century learners. The introduction of flexible learning spaces is intended to provide teachers with opportunities to employ creative and innovative teaching practices that can lead to more robust, continuously improving communities of practice. For this shift to occur teachers will need to change how they think and how they teach, and this is likely to generate a range of reactions. Reactions to change may include "perceptions of risk", which recent research suggests may be a fundamental barrier to change (Jones, 2014; Le Fevre, 2014; Twyford, Le Fevre, & Timperley, 2017). This chapter examines what perceptions of risk are and why they may be prevalent in the context of developing ILEs. Our view is that if researchers, policymakers, educational leaders and practitioners are aware of, and responsive to teachers' feelings of uncertainty, this may mitigate teachers' perceptions of risk. Mitigating teachers' perceptions of risk may result in teachers adapting their practice to maximise the learning opportunities possible in ILEs.

Shifts towards ILEs have been informed by learning theories which reveal traditional teacher-centred transmission models of teaching do not align with how people learn (Dumont, Istance, & Benavides, 2010). An OECD ILE framework has been developed with seven guiding learning principles "proposed as fundamental to all

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schools and learning settings as offering the building blocks of design, improvement and innovation" (OECD, 2017, p. 22). The guiding principles focus on the learners as the core participants, encourages their active engagement and stresses the social nature of learning. The principles also focus on the importance of recognising individuals' differences, motivations and emotions.

In order to fully realise ILEs, changes to physical learning environments are requisite. Flexible learning spaces are identified as a key resource in ILEs, and are intended to be motivating, facilitate engagement and recognise the social nature of learning. However, Fielding and Nair (2005) claim flexible learning spaces will only enable more innovative approaches to learning if the teachers have an understanding of the guiding principles of ILEs and a flexible, risk-taking attitude.

The Concept of Risk

The term risk has been used in numerous ways and in various contexts for many years. In the corporate world, the term "risk" is commonplace; risk management, capital risk and systematic risk all focus on the identification, assessment and prioritisation of commercial risk (Stulz, 1996). In the education sector, the concept of risk is only beginning to be acknowledged in the context of working to understand processes of innovation and change.

A broad definition of risk includes loss, significance of loss and uncertainties (Aven & Renn, 2009; Ponticell, 2003; Trimpop, 1994). Loss, which can be performance related, social, psychological or status related is considered foundational to risk-taking (Ponticell, 2003) and is often discussed in relation to the significance or severity of potential loss to a person (Aven & Renn, 2009). If a teacher perceives certain actions may lead to a greater severity of loss, then he or she will correspondingly react with higher levels of caution. The third element associated with risk is the nature of the uncertainty of an outcome. Uncertainty is inherent to perceptions of risk (Trimpop, 1994).

Why an Understanding of Perceptions of Risk Matters

Teachers are commonly expected to be "doing something that others are suggesting they do" (Richardson, 1990, p. 11). Some teachers willingly trial or implement these suggestions for change, while many others avoid engagement, or are accused of being resistant to, or resilient to change. Forms of resistance such as refusal or withdrawal are commonly reported, yet there appears to be little agreement on either the cause or nature of what is commonly called "teacher resistance", or how to respond to such reactions effectively. The most likely outcomes of what is often perceived as resistance is that it gets in the way of enabling teachers to effectively explore innovation and change.

More recent research recognises that accusing teachers of being resistant to change may be counterproductive to developing a culture of collaborative and sustainable improvement. Rather than blaming teachers, it is important to understand the challenges they experience in order to better support them. Research by Jones (2014), Le Fevre (2014), and Twyford (2016) suggests that teachers' perceptions of risk may influence their engagement in educational change. What might look like resistance may, in fact, be teachers' perceptions of risk. Perceptions of risk which include feelings of uncertainty about change and feelings of vulnerability in relation to engaging in change may cause people to be reluctant to engage in change (Le Fevre, 2014). For example, teachers may perceive engaging in ILEs to be risky to their identity as an educator, or they may lack an understanding of the guiding principles of ILEs and be uncertain about the outcomes for their students' learning.

Theories of Risk-Taking in Education

Why focus on perceptions of risk? Understanding how and why people react to change in the ways they do is essential if we are to support people to change. Theories about risk and risk-taking are powerful levers in seeking to understand how and why teachers react to change in the ways they do. For example, research indicates perceptions of risk can interrupt teachers' engagement in change initiatives and may be "a significant roadblock to engaging in educational change" (Le Fevre, 2014, p. 64).

Research has suggested that the degree of teacher willingness to engage in change initiatives may be a personal trait and stem from personal practical theories or an individual teacher's risk attitude. Teachers develop strong identities and "personal practical theories" throughout their careers (Maaranen, Pitkäniemi, Stenberg, & Karlsson, 2016). Personal practical theories are formed through experience and reflection; they forge a teacher's identity and with more teaching experience become ingrained; they are "something they just do, and are a part of who they are as teachers" (Levin, He, & Allen, 2013, p. 213). Personal practical theories are significant when we come to consider what happens when teachers are expected to change the way they teach. The unquestioning acceptance of ingrained personal practical theories of teaching may result in teachers closing themselves off to learning how to work in ILEs. However, it may also be that an individual teacher's risk attitude influences risk-taking behaviour (Baylor & Ritchie, 2002; Le Fevre, 2014), which Baylor and Ritchie (2002) claim is difficult to influence.

An alternate theory of risk-taking in education is that groups and cultures, which have diverse social principles, guide risk behaviour and judgement of what is deemed a risk and who should be allowed to take risks. Rosa (1998) suggests that, "since identification of risks is entirely a social process, risks do not exist in objective reality, but in the collective consciousness of cultures" (Rosa, 1998, p. 21). What one school culture perceives as a risk may not be deemed a risk for another.

While ILEs may have many affordances for more effective pedagogies, their success will depend on teachers taking risks to exploit their potential. Understanding how affective factors such as perceptions of risk, or feelings of uncertainty can cause teachers to react is an important area for research (Jones, 2018) and is the focus of the empirical research explored in this chapter.

To capture the complex connections between school leaders' and teachers' understandings of ILEs, and their reactions to expectations to transition to ILEs, the first author employed a three-school case study approach. The research also investigated forms of support that mitigated teachers' perceptions of risk and enabled teachers to work collaboratively in ILEs. The research explored three key questions:

(1) What are school leaders' and teachers' understandings of Innovative Learning Environments?
(2) How do teachers react to expectations to engage in Innovative Learning Environments?
(3) What forms of support do teachers perceive enable them to develop their understanding of Innovative Learning Environments, and engage in innovative practices?

Methods

The qualitative empirical study this chapter draws on involved three New Zealand elementary schools. Teachers in the three schools selected were expected to explore or implement ILE teaching approaches. The data collection methods included semi-structured interviews, observations, document analysis of online teacher journaling and publicly available school documentation.

Interviews were conducted with eighteen teachers from the three schools twice during the year. During the initial interview, participants were asked to explain their understanding of ILEs, share innovative practices they had recently implemented, and discuss what had supported or challenged them to change their practice. In the follow-up interview participants were asked to identify any changes in their understanding of ILEs, discuss their feelings about being expected to engage in innovative practices, and share professional learning opportunities that had impacted on their understanding of, and practice in ILEs. Four school leaders were also interviewed to ascertain their understanding of ILEs and gain an insight into their processes for supporting teachers to transition into ILEs.

Prolonged engagement and numerous observations in the field provided an understanding of how teachers had developed their perceptions of ILEs and why they reacted the way they did to expectations to engage in innovative practices. Data were analysed using an inductive and deductive thematic approach and coded using NVivo. Thematic maps were developed based on teachers' and leaders' understandings of ILEs, leaders' expectations of teachers to engage in ILEs, teachers' reactions to the expectations, and to the professional support provided. Member checking, triangulation of data, negative case analysis and inter-coder reliability ensured the trustworthiness of findings.

Understandings of the Rationale for ILEs

All school leaders in the study understood that economic, social and technological developments were driving educational change, however, the depth of the leaders' understandings of ILEs differed and the nature of their understanding influenced how they supported the teachers in their schools.

In the school where teachers made the biggest transition to ILEs (School One), the school leaders shared a mutual understanding that traditional models of teaching and learning were no longer adequate to equip students. The leaders' rationale for change was that students would need twenty-first-century learning skills to survive and thrive in an unknown future. The leaders in School One also understood that leading change necessitated engaging in dialogue with staff about their understandings and how they aligned with the school vision. Rather than pontificating about the world changing and the need to be "leading edge", these school leaders focused on why they perceived ILEs could better suit their learners. The leaders referred to the guiding principles of ILEs and provided literature on twenty-first-century learning competencies. Teachers were encouraged to share their understanding of ILEs and their perceptions of risk engaging in practices that promote the principles of ILEs.

How the School One leaders discussed the rationale for change influenced the teachers' engagement. Through ongoing discussions about the rationale of ILEs many teachers were able to articulate deep understanding of ILEs. Having opportunities to engage in dialogue about the reasoning for the shift to ILEs enabled teachers to question their pre-existing conceptions about teaching and learning and to think through the implications for their beliefs, values and pedagogies (Hargreaves, 1994). Such discussions enabled many of the teachers to consider the possible benefits to students' learning if they stepped away from their familiar and "safe" teaching methods.

The professional conversations about ILEs had an additional benefit of enabling many of the teachers to develop a deeper level of collegial trust. Having opportunities to share perceptions of risk, and having these acknowledged by the school leaders, empowered the teachers to step into a degree of uncertainty and engage in the change process. This finding supports conclusions drawn in Twyford's (2016) study that found supportive relationships were essential for teachers to take risks when they lacked confidence or were uncertain in their state of knowledge.

In contrast, the school leaders in School Two and School Three could not articulate a clear rationale for why there was a global drive to establish ILEs. One of these school leaders expressed her perception that promoting student agency while being responsive to students' motivations could distract teachers from the "essence of education, what is important to learn". The other leader perceived it to be the teachers' (not the leaders') professional responsibility to unpack what "innovative" could look like for their students. Discussions about why ILEs may better suit the needs of twenty-first-century learners were absent in both of these schools. Instead, conversations focused on teachers' perceptions of what ILEs should look like. Circumventing conversations with leaders about the rationale for change resulted in many teachers in these schools focussing on surface features such as furniture while maintaining vague, inaccurate or conflicting understandings of the underlying principles of ILEs.

The ways teachers engage in new initiatives are shaped by their personal practical theories (Maaranen et al., 2016). Teachers use their past experiences and existing knowledge to notice, construe, construct and implement change (Spillane, 1999). In the context of ILEs, if teachers have limited experience or knowledge of the guiding principles of ILEs they may struggle to effectively engage in innovative practices. School leaders need to be aware of teachers' pre-existing frames and existing knowledge and provide professional support to enable teachers to develop shared, and accurate, understandings of ILEs. Obviously, this is problematic if leaders themselves cannot articulate a clear rationale for ILEs.

Developing Expectations to Engage in ILEs

When teachers understood why they were being expected to engage in ILEs, and how or what to change, they were more willing to take risks, tolerate uncertainty and explore new practices. Teachers' reactions were also generally more positive when they were provided with autonomy and control of the change process and when they had opportunities to work with school leaders to clarify expectations.

The leaders and teachers in School One, where change was most evident, worked together to generate expectations that they perceived could be achieved, and which aligned with the school's vision of ILEs. During meetings, the teachers discussed their understanding of ILEs and collated a list of innovative actions that they felt demonstrated their understanding. They discussed implications for practice and potential challenges that might thwart the success of the innovations. Through this process, the teachers worked alongside the leaders, they clarified and refined their understanding of ILEs and had opportunities to connect new theoretical learning with their existing pedagogical knowledge. These teachers had input into, and ownership of, the way ILEs were established in their school. The ongoing discussions made visible the potential merits of ILEs and also the challenges. The act of acknowledging the challenges and planning for them reduced many teachers' feelings of uncertainty. Establishing clear expectations did not completely mitigate these teachers' perceptions of risk but resulted in them working towards achieving the expectations and feeling more positive about exploring ways to work in ILEs.

For decades, scholars have emphasised the importance of teachers perceiving themselves to be change agents and having a level of control over the change process for educational reform to be successful (Fullan, 2011; Hargreaves, 2004). When teachers lack an understanding of what, why or how to change, and perceive that they are viewed only as implementers, the implementation will often be superficial (Ungar, 2016). Such superficial engagement was evident in the two schools where the rationale for ILEs and expectations were not understood, transparent or shared.

Supporting Teachers to Engage in ILEs

Targeted professional learning support may increase teachers' engagement in ILEs (Jones, 2018), however, teachers working in seemingly similar conditions may perceive forms of support differently. Different perceptions of support were influenced by teachers' prior experiences, learning needs and perceptions of what constitutes professional support. This finding highlights how fundamentally complex educational change can be, and supports Ungar's (2016) suggestion that school leaders offer teachers different forms of support depending on teachers' needs and the needs of their students.

School leaders who make tactical choices about the professional learning available to teachers are in a better position to support teachers to engage in ILEs. In School One, leaders understood that teachers could be distracted by extraneous professional learning. Consequently, they identified which professional learning initiatives should be prioritised and which should cease. The leaders in this school also accepted that teachers were at different stages of comfort, transitioning from traditional practices to ILEs, and had different learning needs. To better support the teachers' individual needs, the leaders encouraged the teachers to source professional learning that they perceived would assist them to develop their understandings of ILEs. The teachers valued the opportunity to self-select what they perceived to be of value to their specific needs and context.

In contrast, leaders in Schools Two and Three implemented a one-size-fits-all approach to professional learning. These programmes consisted of a multitude of unrelated and episodic professional learning sessions which did not take into account the different needs of the teachers. The fragmented, short-term professional learning sessions resulted in a disjointed diffusion of effort. Furthermore, teachers in these schools lacked an understanding of how the professional learning connected to the school vision and described feeling overloaded, uncertain, frustrated and ultimately disengaged from the change process.

In addition to the extensive professional learning, teachers in Schools Two and Three were expected to explore innovative practices in collaborative professional inquiries. The literature on professional collaborative inquiries points to key characteristics of effectiveness. These characteristics include shared values and vision, collective responsibility, clear expectations, promotion of group and individual learning, and a culture of collaboration within the school (DeLuca et al., 2015). It was evident in this study that most of these characteristics for effective collaboration were absent. Inquiry meetings consisted of teachers having congenial conversations that focused on sharing stories of practice and suggestions for adapting practices. Nelson, Deuel, Slavit, and Kennedy (2010) caution that when teachers have superficial conversations about practice, “fault lines can be avoided because an examination of the value of those ideas remains private” (p. 176). However, the lack of professional probing into practice resulted in teachers not inquiring deeply into their practice or that of their colleagues.

Supporting teachers to shift from “congenial but relatively superficial conversations to dialogue that is more productive for improving student learning entails risk-taking and trust” (Nelson et al., 2010, p. 176). Nelson et al. (2010) suggest that intentional and transparent actions are required to enable teachers to engage in substantive and specific dialogue about teaching and learning. Teachers require support to learn how to have productive conversations, reflect on evidence and act.

Revisiting Perceptions of Risk and Uncertainty

Teachers were hesitant to use the term “risk” to describe their reactions to expectations to engage in ILEs. A teacher explained, “risk sounds dangerous, I don’t think there is danger”. Instead, teachers described feeling concerned or uncertain about engaging in ILEs, reactions they perceived to be less severe. As discussed earlier, uncertainty is inherent to perceptions of risk. Uncertainty is a key element often associated with risk because there is uncertainty of an outcome, and uncertainty in the perceived probability of its outcome value (Trimpop, 1994).

Perceptions of risk or feelings of uncertainty were acknowledged by teachers in the three schools. Teachers were uncertain how to effectively monitor student learning and were uncertain how to establish close relationships with students and the students’ families in ILEs. Teachers also expressed feeling uncertain of ways to work collaboratively with colleagues. Their feelings of uncertainty stemmed from being expected to work with colleagues who had different understandings of ILEs, different pedagogical practices, incompatible personalities or different interpretations of what collaboration entailed.

In summary, many teachers were uncertain whether the benefits of ILEs outweighed the challenges. However, teachers’ perceptions of risk and feelings of uncertainty were mitigated when school leaders provided a clear rationale for why a shift to ILEs might better suit twenty-first-century learners, and provided with explicit expectations of what or how to change, and targeted support to engage in ILEs. As Dinham (2000) explains, “often, it is not change per se that is the problem for teachers and schools, but the way that change is introduced” (p. 32).

Implications for Policy and Practice

Enacting change "requires tremendous sophistication as well as some risk-taking" (Fullan, 2007, p. 2). It demands leadership with a clear understanding of the rationale for innovation and the capacity to lead change. The school leader's role is generally accepted as being "a central component in securing and sustaining school improvement" (Muijs & Harris, 2003, p. 437), and it is pivotal in situations when an externally mandated reform, such as ILEs, is being imposed. Leaders in this study who understood why a shift to ILEs might better suit the needs of twenty-first-century learners were able to "create a fit between policy and practice, or at least lessen the misfit" (Razzaq & Forde, 2013, p. 67). Managing change by integrating it with the priorities of their context and engaging in ongoing dialogue about the change enabled the school leaders and teachers in School One to work more purposefully. This reduced teacher perceptions of risk. Portoghese et al. (2012) state that providing change-related information is fundamental to the success of any reform. Information can mitigate feelings of uncertainty and anxiety, which is essential for creating openness towards change initiatives: "Information is crucial in shaping employees' expectations and providing a basis for developing attitudes (positive and negative) toward change" (Portoghese et al., 2012, p. 584). This reflects the situation in School One.

In contrast, findings from Schools Two and Three indicate that leaders who cannot articulate the rationale for change, align their reasoning with realistic and explicit expectations, and remove distractions will struggle to motivate teachers to engage in ILEs. From this research, one could point the finger of blame at school leaders, however, a better solution may be to use a wider lens. If policymakers, professional learning facilitators, school leaders and teachers work together to understand the different challenges of implementing ILEs and design ways ILEs can be implemented, student outcomes are more likely to improve.

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References

Aven, T., & Renn, O. (2009). On risk defined as an event where the outcome is uncertain. *Journal of Risk Research, 12*(1), 1–11. https://doi.org/10.1080/13669870802488883.

Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms? *Computers & Education, 39*(4), 395–414. https://doi.org/10.1016/S0360-1315(02)00075-1.

DeLuca, C., Shulha, J., Luhanga, U., Shulha, L. M., Christou, T. M., & Klinger, D. A. (2015). Collaborative inquiry as a professional learning structure for educators: A scoping review. *Professional Development in Education, 41*(4), 640–670. https://doi.org/10.1080/19415257.2014.933120.

Dinham, S. (2000). Teacher satisfaction in an age of change. In S. Dinham & C. Scott (Eds.), *Teaching in context* (pp. 18–35). Camberwell, VIC: The Australian Council for Educational Research.
Dumont, H., Istance, D., and Benavides, F. (Eds.). (2010). *The nature of learning: Using research to inspire practice. Educational research and innovation.* Paris: OECD Publishing. https://doi.org/10.1787/9789264086487-en.
Fielding, R., & Nair, P. (2005). *The language of school design: Design patterns for 21st century schools.* Minneapolis: The National Clearinghouse for Educational Facilities and The Knowledge Works Foundation.
Fullan, M. (2001). *The new meaning of educational change.* London: Routledge.
Fullan, M. (2007). *The new meaning of educational change* (3rd ed.). New York: Teachers College Press.
Fullan, M. (2011). *Choosing the wrong drivers for whole system reform.* Melbourne, Australia: Centre for Strategic Education.
Hargreaves, A. (1994). *Changing teachers, changing times: Teachers' work and culture in the postmodern age.* New York: Teachers College Press.
Hargreaves, A. (2004). Inclusive and exclusive educational change: Emotional responses of teachers and implications for leadership. *School Leadership and Management, 24*(3), 287–309. https://doi.org/10.1080/1363243042000266936.
Jones, T. K. (2014). *Theories of risk-taking and primary teachers' engagement in professional learning for change.* Dissertation submitted in partial fulfilment of the degree of Master of Education. New Zealand, University of Auckland.
Jones, T. K. (2018). *Working in wonderland; teachers' reactions to innovative learning environments.* Unpublished doctoral thesis, University of Auckland, Auckland, New Zealand.
Le Fevre, D. M. (2014). Barriers to implementing pedagogical change: The role of teachers' perceptions of risk. *Teaching and Teacher Education, 38,* 56–64. https://doi.org/10.1016/j.tate.2013.11.007.
Levin, B. B., He, Y., & Allen, M. H. (2013). Teacher beliefs in action: A cross-sectional, longitudinal follow-up study of teachers' personal practical theories. *The Teacher Educator, 48*(3), 201–217. https://doi.org/10.1080/08878730.2013.796029.
Maaranen, K., Pitkäniemi, H., Stenberg, K., & Karlsson, L. (2016). An idealistic view of teaching: Teacher students' personal practical theories. *Journal of Education for Teaching, 42*(1), 80–92.
Muijs, D., & Harris, A. (2003). Teacher leadership—Improvement through empowerment? An overview of the literature. *Educational Management & Administration, 31*(4), 437–448. https://doi.org/10.1177/0263211X030314007.
Nelson, T. H., Deuel, A., Slavit, D., & Kennedy, A. (2010). Leading deep conversations in collaborative inquiry groups. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83*(5), 175–179. https://doi.org/10.1080/00098650903505498.
OECD. (2017). *The OECD handbook for innovative learning environments.* Paris: OECD Publishing.
Ponticell, J. A. (2003). Enhancers and inhibitors of teacher risk taking: A case study. *Peabody Journal of Education, 78*(3), 5–24. https://doi.org/10.1207/S15327930PJE7803_02.
Portoghese, I., Galletta, M., Battistelli, A., Saiani, L., Penna, M. P., & Allegrini, E. (2012). Change-related expectations and commitment to change of nurses: The role of leadership and communication. *Journal of Nursing Management, 20*(5), 582–591. https://doi.org/10.1111/j.1365-2834.2011.01322.x.
Razzaq, J., & Forde, C. (2013). The impact of educational change on school leaders: Experiences of Pakistani school leaders. *Educational Management Administration & Leadership, 41*(1), 63–78. https://doi.org/10.1177/1741143212462698.
Richardson, V. (1990). Significant and worthwhile change in teaching practice. *Educational Researcher, 19*(7), 10–18. https://doi.org/10.3102/0013189X019007010.
Rosa, E. A. (1998). Metatheoretical foundations for post-normal risk. *Journal of Risk Research, 1*(1), 15–44. https://doi.org/10.1080/136698798377303.

Spillane, J. P. (1999). External reform initiatives and teachers' efforts to reconstruct their practice: The mediating role of teachers' zones of enactment. *Journal of Curriculum Studies, 31*(2), 143–175. https://doi.org/10.1080/002202799183205.
Stulz, R. M. (1996). Rethinking risk management. *Journal of Applied Corporate Finance, 9*(3), 8–25. https://doi.org/10.1111/j.1745-6622.1996.tb00295.x.
Trimpop, R. M. (1994). *The psychology of risk taking behaviour*. Amsterdam: North-Holland.
Twyford, K. (2016). *Risk or resistance: Understanding teachers' perceptions of risk in professional learning*. Doctoral thesis, University of Auckland, Auckland, New Zealand.
Twyford, K., Le Fevre, D., & Timperley, H. (2017). The influence of risk and uncertainty on teachers' responses to professional learning and development. *Journal of Professional Capital and Community, 2*(2), 86–100. https://doi.org/10.1108/JPCC-10-2016-0028.
Ungar, O. A. (2016). Understanding teachers' attitude toward educational reforms through metaphors. *International Journal of Educational Research, 77,* 117–127. https://doi.org/10.1016/j.ijer.2016.03.008.

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Pedarchitecture: Which Learning Environments for the Personalisation of Teaching and Learning? An Educational Architecture for the Schools of the Future

Mariagrazia Francesca Marcarini

Abstract This project investigates how to overcome traditional learning environment's rigidity; those established practices that may hinder full use of what we might call new learning environments. It addresses how teachers adapt their teaching to changing learning environments, what impact new educational spaces have on teachers and students, how to organise students with different criteria, and how learning environments can be redesigned in old schools with limited investments. The research studies four schools: in Denmark, the Hellerup Folkeskole in Gentofte and the Ørestad Gymnasium in Copenhagen; in Italy, the Enrico Fermi High School in Mantua and IC3 Piersanti Mattarella secondary first grade in Modena. New learning environments are intended to enhance teacher collaboration and stimulate the exchange of new teaching methods, enabling learning personalisation. This is often facilitated by team teaching, which in this chapter is seen as a "bridge-culture" concept, offering a wider vision including structural and organisational details. The chapter discusses how this strategy lead to students improved learning skills, them taking on greater personal responsibility and displaying aptitude to study in different ways. In this sample of "architecture feeds pedagogy" schools, some key concepts are explored that might guide future learning environments design: readability, "semantic-topical", flexibility, invisible pedagogy and affordances.

Introduction

The cultural background that characterises societies is undergoing a steady transformation, and schools are involved in this change. Teachers are increasingly being asked to evolve their disciplinary knowledge and teaching methodology according to the integral growth of the student and her/his understanding of new social and employment needs. This is only possible if there is an anthropological vision of education that adopts a global and comprehensive approach, so that the individual's development is central and integral to the schooling structure. This can be done in

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many ways, but surely the organisation of the spaces and new school architecture, where the school is a "third teacher", are elements that need to be taken in account?

Although at first sight architecture and pedagogy fields of study seem distant from each other, the collaboration between the two disciplines is being more widely studied and analysed. This chapter will tackle the fundamental question of whether it is possible to overcome the traditional spatial rigidity which views "schools as a factory, the child as its product, the teacher as a worker and curriculum as its management system" (Imms, 2016a, pp. 151–52) and propose "new ways of doing school" with new learning environments helping to drive new teaching methodologies (OECD, 2009).

Why is the relationship between person, education and space so important? Education is a global process involving all the supportive structures for human life (Ruini, 2009). In this scenario, the school's role is to support personal development in a process where "the person shapes himself in order to become a person" (Maritain, 1943, p. 12). Teachers must be able to apply disciplinary knowledge and teaching methodologies according to the integral growth of the student (Bertagna, 2006) so that beyond just learning, dignity creativity and the basic right to schooling and education are recognised for everyone (Mounier, 1935).

The relationships between education and schooling are complex because one cannot educate without teaching, while it is easy to teach without educating (Arendt, 1961); the relationship that exists between the teacher and the learner is critical, and this chapter argues that the spaces within which this relationship is enacted is an element of this complexity (Byers, Imms, & Hartnell-Young, 2014). In the eighteenth century Jean Jacques Rousseau identified the importance of physical spaces as the "third teacher" (Rousseau, 1762, p. 10), and wrote that "each of us is therefore made up of three kinds of masters" and that "education comes from nature or from people or things" (Rousseau, 1762, p. 10). Later the educational philosophies of Maria Montessori, Loris Malaguzzi and Trung Le reinforced this by emphasising the importance of space working in partnership with the instructor in effective learning. For example, in terms of furniture, the location of student and teacher desks can influence students and regulate their behaviour (Foucault, 1975; Hall, 1959). The teacher can be conceived as a theatre director who, by changing the teaching environment, can produce a different scenario and therefore introduce a new teaching model (Gamelli, 2001).

Flexible school spaces are argued to allow adaptation to the different needs and "multiple intelligences" (Gardner, 1993) of students; teachers can be modified over time through an educational relationship involving all those participating in the educational process. The analysis of data presented in this chapter starts with the relationships between people, education and learning environments, through the lens of its potential to stimulate personalised learning. The student must be considered as a human being (Bertagna, 2012) in a position to make choices, be independent, responsible, self-sufficient (Hoz, 1988) and conscious of his or her learning (Collins, 1991; Dent-Read & Zukow-Goldring, 1997; Lippman, 2010; Santoianni, 2010). Personalised learning is the most useful strategy (Hopkins, 2008), so that each student reaches the best possible results (Miliband, 2006).

In order to understand how new learning environments can facilitate this type of teaching methods and learning, it is important to study the complex interaction of people, actions, education and school spaces. The school building can be seen as a site for this; they represent a "pedagogical problem" because "the school environments assume a fundamental importance for the educational process … and environment in this sense means equipment, furnishings, teaching supports" (Coèn, 1965, p. 5) as well as the relationships between the teachers and students. Any interpretation of pedagogy must recognise an encompassing overall view of the total educational phenomena, and within the chosen methodological orientation to accept that people are the subject-object of research, and they are involved in all educational actions related to them in concrete situations.

In the relationship between education and school "the building sets the method" (Romanini, 1962, p. 21). "The question of the epistemological pre-requisite on the person's centrality" is fundamental (Pavan, 2003) according to those philosophical assumptions (Mertens, 2014) that recognise a strong orientative value (Mortari, 2012).

The analysis of educational actions is very complex and for this reason this chapter argues it is a perspective that requires one "to base one's intentionality on clear and explicit paradigms, capable of nourishing the reading and interpretation of experiences" (Sandrone, 2010, p. 6). This is because the reality in which pedagogy takes place is multifaceted, ephemeral and complex. So too must research be flexible; "Every research takes place within the framework of a paradigm" that "guides action" (Mortari, 2012) or may, explains Mertens, be "the way of looking at the world" (2014) with a perspective that orients it. For this chapter an ecological paradigm has been chosen using the lens of the European Personalist Movement (Emmanuel Mounier, 1935; Jacques Maritain, 1943; Paul Ricoeur, 1983) drawing on epistemological and anthropological structures of the individual and the influence that learning environments have, along with proxemics dimension and strong symbolic value of furniture present in the classrooms.

The research informing this chapter is aimed at understanding if learning spaces, built according to an innovative pedagogical vision or modified at the organisational and structural level, might (1) bring a change in teaching methodologies, (2) allow greater collaboration and sharing of work among teachers and (3) improve the well-being, motivation and attitude of students at school. In order to get an understanding, even if partial, of how learning environments can be structured in an innovative flexible, beautiful and pleasant way, four schools, two in Denmark (Gentofte and Copenhagen) and two in Italy (Mantua and Modena), have been analysed. As the cultural context is different, we do not intend to make a comparison but rather analyse how the educational spaces have been designed and/or reorganised with new technologies and new teaching that allows each person's abilities development in personal skills.

Methodology

This research has an explorative character using qualitative survey techniques and case study methodology. It is also focused on specific analysis by "mixing" the Phenomenological-Eidetic and Grounded Theory methods, with a "hermeneutical approach" (Mortari, 2012, p. 193). This has allowed a thorough understanding of the situation in its uniqueness and specificity (Trinchero, 2002) and to simultaneously safeguard the features of real-life events (Yin, 2003). The research considered numerous existing factors as well as some factors that were not fixed beforehand (Trinchero, 2002). Four schools were chosen as examples which represented unique situations (Merriam, 1998). The choice of multiple techniques was made to grasp the multifaceted and varied reality of the analysed situations, but with the awareness that the analysis is certainly partial and focuses only on some aspects rather than the complete picture (Silverman, 2000).

An initial exploratory survey was made to choose the epistemic instruments and better identify the research aspects and the interview questions. This included papers and documents supplied by the schools (Staff of Hellerup Skole, 2012) or found on-line, videos and photographs, direct observation of the school premises as well as the observation of the interactions on the field. In this research, single and group interviews were used, allowing the interviewer to give explanations in case of interpretative difficulties and, thanks to the group dynamics stimulating the interviewees, allowing the researcher to obtain more detailed information. Trinchero (2002) makes a distinction between "between group" interviews, in which the interviewer asks questions to more than one person and more than one person responds, and "in a group" interviews in which the interviewer asks questions to a person at a time, in the presence of the whole group and only that person responds.

The questions were formulated quite homogeneously, with variations for some questions depending on the different study years of students, thus the professional focus of the teachers. The questions included in the survey concerned the possibility of overcoming the traditional spatial rigidity to propose "new ways of doing school", and potential educational actions based on the concept of personalization of teaching and learning.

The aim was to answer the following questions:

– How have teachers adapted their teaching to changing learning environments?
– How can the educational setting be changed for teaching and learning personalisation?
– What impact might new learning environments have on teachers and students' perception?
– How can learning environments be redesigned in old schools with limited investments?

Case Study Sites

In essence, the schools presented in this research are very far from a functional determinism that typifies the majority of schools built in the past. They are, each in differing ways, experimental or progressive schools; this has allowed the stakeholders to appropriate the spaces and to change their role from “users” to “inhabitants” (Faiferri, 2012). They also allow teachers to propose new teaching methods to students, and above all to develop a sense of belonging, feel well-being and feel good at school as at home. This purposive sampling allows the research to properly explore the stated research questions.

Denmark

In Denmark, the case study sites were the Hellerup Folkeskole in Gentofte, for students 6–15 years old, and the Ørestad Gymnasium in Copenhagen for teenagers aged 17–19. The choice of Denmark was made for three reasons. The first relates to investments that have been made in the school architecture after the poor results in the OECD-PISA 2000 survey. The second concerns the choice of two schools that interpreted the Danish Government’s directions on education to design new schools where it was possible to propose an innovative teaching method with the student as the centre of the education process, acknowledging and utilising various learning styles (McGrane, 2012). The third is historical: in Denmark since 1844 laws have been issued requiring adequate and clean classrooms, stressing the influence of the educational spaces on child development (Vindum, 2007). The “*2000 Debate Paper on Folkeskole Vision 2010*”—states that a “radical change” of building projects is needed so that there is an inevitable break with the traditional organisation of teaching methods (Undervisningsministeriet-UVM, 1999).

The ambition was to change the school culture by changing the physical environment, so that teachers were put in a position to rethink their teaching practices and forced to change the teaching methodology and their way of “doing school”. As a result of that document the design and building of new schools has included input from the various stakeholders, including children, because it is part of the school change process to listen to the voice of the pupils with the intent of understanding how the environment can be structured to make them feel calm, serene, peaceful and able to learn (Juelkjær, 2012).

Hellerup Skole

Hellerup has about 650 students and is entirely an open space, spread over three floors with the students distributed according to age. There are nine Home Areas where students’ daily life takes place. The large central staircase, the “heart” of the school, connects the floors as a metaphor of life: one step a day to reach the goal (AA.VV., 2012). Hellerup was built through the SKUB (The School of the Future) programme developed in Gentofte and inaugurated in 2002. SKUB was a restricted programme, but very significant because it created a trend in Europe proposing a new vision of the school (Juelkjær, 2012).

The design of the building started with a pedagogical vision of an inclusive project that involved the whole community (Woolner, 2010, 2015). The environmental qualities of the space now creates a pleasant and familiar atmosphere with muffled and diffused sound, natural light from a ceiling skylight and no bell to demark lesson times. At the corners of these areas there are the Home Bases, two by two-metre hexagonal moveable structures where pupils sit to listen to teachers' explanations for about twenty minutes. They then choose where to sit and work where it suits them at the tables, lying on the floor, on the sofas in the relaxation areas or on the hexagonal-shaped steps.

Through observation one can see that thanks to careful planning and teachers' collaboration, each student is engaged in their small or large group activities or alone in complete freedom [1]. This enables the personalisation of student learning and empowerment [2] and the teachers promote learning by trying to identify the nearest zone (Vygotsky, 1980) of each student.

Ørestad Gymnasium

The Ørestad Gymnasium was built in 2007 in response to the Danish governments new vision for the organisation of spaces in school buildings. With about 1200 students, Ørestad was designed on the principle of "one room, one school" [3]. Visiting the school for this project, it now presents as a large cube-shaped building with several floors connected by a helix staircase, what feels to be the throbbing centre of the school. The pedagogical goals of the school provide an interdisciplinary synergy supported in part through the use of information technology to create a "paper free school" with all the educational material being digital, and students only using iPads.

The central core of the school is dominated by a large spiral staircase that dramatically links the floors. It is a space for relationships, a place for meeting and socialising. There are few classrooms compared to the number of students because "school takes place outside school" [4]. Through a network of companies, students have the opportunity to take some lessons outside the physical boundaries of the school. The school is an "exploration ground where teachers constantly develop new methodologies allowing each student to learn, be independent, develop their own opinions and to be able to work in a team" [5]. There are several possible space lay-outs/settings available to teachers and students: open spaces for individual work; a meeting room where students work in teams monitored by teachers; a classroom with glass walls; where students attend brief quite didactic lessons; open areas that can be transformed into large spaces where, for example, three teachers can work with about ninety students; and a large room that can hold a very large number of students.

Italy

Enrico Fermi Institute

In Italy, the Enrico Fermi High School in Mantua caters for teenagers aged 14–19. Known as a high school of applied sciences, it is now an example of what is possible in old schools with limited investment, but with concerted attention given to innovative pedagogies and teaching methodologies. Fermi was the first school in Italy to organise school spaces with "Readable Subject Classrooms" (Fig. 1) in the 2011/2012 school year.

The Fermi Institute has around 1800 students. It used to be a school with very traditional teaching methodologies centreed on the teacher. In recent years, the headmaster's vision has led to significant change, beginning with updating technological infrastructure to allow for modern computer technologies. Following that, subject classrooms were created and assigned to the teachers so that the students move at the change of lessons instead of the reverse. Subject teachers share the same classroom and have all the materials (personal computer, multimedia interactive whiteboard, books) available for their lessons. The headteacher created in teachers a "sense of urgency" (Kotter, 1996, p. 35) and an awareness of the need to change so that teachers can "collectively" create this change (Armenakis, Harris, & Mossholder, 1993).

By dismantling the partition walls of some classrooms during the 2012/2013 school year, TEAL (Technology Enabled Active Learning) (Dori & Belcher, 2005) classrooms (Fig. 2) with origami desks and Debate classroom were created (Fig. 3). Redesign of some unused areas created informal spaces for relaxation and individual

Fig. 1 Languages classroom

Fig. 2 TEAL classroom

Fig. 3 Debate classroom

Fig. 4 Widespread library

study. Financial investment has been limited, but what has been forthcoming has assisted the development of revitalised pedagogical approaches, resulting in new teaching methodologies and higher motivation and student learning [6].

In the 2020 school year, the new headteacher wanted to further improve some areas of the school to meet emerging student needs, so new learning environments were created. Spaces that had remained largely unused have become a widespread library (Fig. 4), relaxing areas, and spaces for individual and small group study.

The headteacher, the teachers and the students were interviewed about the impact of modifications and general reorganisation of the school spaces to make them more innovative. In her interview the head teacher explained how she approached the transition from a traditional situation to an innovative situation by trying to involve some teachers. The important thing was that the headteacher had support from a group of teachers who helped her in the reorganisation, and this motivated even the most reluctant teachers. This is consistent with leadership's need to create a fundamental educational community (Sergiovanni, 1994).

IC3 Piersanti Mattarella

The IC3 Piersanti Mattarella in Modena, catering to students aged 11–14, is a comprehensive middle school. It was inaugurated in September 2016, and has become known as an aesthetically pleasing and innovative institution. It now maintains tradition with subject classrooms allocated to the teachers, with some spaces such as the library and the computer lab open to general use, and with an architectural project that reflects the pedagogical project shared among teachers.

The IC3 Piersanti Mattarella in Modena has about 180 students and was inaugurated in September 2016, but its project dates back several years earlier. The building was intended to be a primary school, but the needs of the neighbourhood changed and consequently the project had to be revised.

A group of teachers proposed a review that included the creation of classrooms assigned to teachers. Some of these "breakout or quiet area" (Nair & Fielding, 2005; Sandri & Marcarini, 2019); named "L'isola che c'è—The island there is" (referring to a famous Italian song titled "L'isola che non c'è"), (Figs. 5, 6 and 7), with a soft corner enables the possibility of using them for individual study moments or very small or peer group activities or for student with disabilities, so they can stay inside the classroom with their classmates and not outside in a special room. Students' personal lockers play an important role in the pedagogical project, as they stimulate student autonomy and decision-making capacity. According to Romanini (1962), the individual didactic locker must be comfortable and "inviting" similarly to the affordance concept by Gibson (1979). Students are obliged to plan the organisation of their teaching materials according to the lessons in the morning when they arrive at school, at the interval and at the end of the lessons.

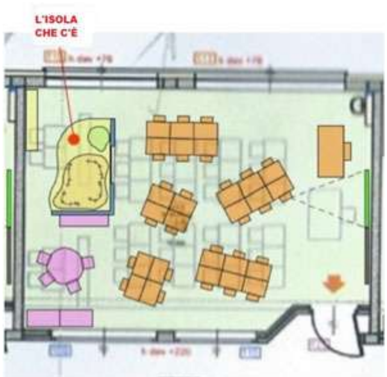

Fig. 5 Classroom plan with "L'isola che c'è—The island there is"

Fig. 6 "L'isola che c'è—The island there is" seen from the front

Fig. 7 "L'isola che c'è—The island there is" seen inside

Fig. 8 Spazio L.E.O.—L.E.O. space

In May 2019 the L.E.O. (Learning Expression On-the-job) space (Fig. 8) was created by the architect Francesco Bombardi. It is based on a design by Leonardo da Vinci. It is a large space adapted to a multifunctional laboratory organised on four "knowledge" rafts: Technological (Robotics/Virtual Reality/FabLab); Performance (Videomaking, Radio, Podcast); Agri-food (Hydroponic Greenhouses, Microscopes, Extractors, 3D Food Printing); Stage (Theater, Cinema, Debate).

The space is truly innovative and aesthetic, incorporating some specific technical solutions: an industrial style ventilation system that keeps the room warm in winter and cool in summer; the vertical sound-absorbing panels hanging from the ceiling that allows each group of students to not disturb the others and the Carnovsky RGB curtains (by Francesco Rugi and Silvia Quintanilla art designer) that favours a visual separation of the different rafts and areas of activity, creating surfaces that interact with different chromatic stimulus.

Method

The results are a selection of narrative material collected during the interviews from the perspective of the interviewer. Regarding the interviews in Denmark, English was used as the language during the interviews as it was a medium between the mother tongue of the respondents, Danish, and the mother tongue of the researcher, the Italian. Then there was a subsequent task of transcription and translation, with a further interpretative passage.

In Denmark, at the beginning of the interviews, photos of old schools or of very traditional teaching methods were shown as a lead-in. At Hellerup the interviews involved the headteacher, one teacher for 7–9 year old children (1st–3rd grade), one for 10–12 year olds (4th–6th grade), one for 13–15 year olds (7th–9th grade), the Coordinator of Students with Special Needs and a group of five students of different ages (7th–9th grade). We also participated as observers in two primary school lessons.

At Ørestad the interviews involved the rektor, two teachers and a group of six students of different ages, from first to third years. We also participated as observers one large group lessons involving two classrooms students.

At Istituto Enrico Fermi in Mantua, videos of Danish schools were shown before the interviews. The interviews focused on headteacher and on a group of six teachers of the first and second years, a group of six teachers from third to fifth years. Both groups consisted of high school and technical institute teachers. We participated as observers in some classrooms and TEAL space during the lessons.

At IC3 Mattarella, the interviews focused on the vice-headteacher, two different groups of five teachers and three groups of students; two groups of first and second year, and a mixed group of first and second year. We participated as observers in math and science classrooms during the lessons.

The survey questions were developed to address key issues' through a literature review and by reading and analysing the initial pedagogical projects of the two Danish schools (Hellerup and Orestad) and Mattarella Institute. For Fermi Institute, which had no written projects, but only educational practices related to activism, we interviewed the headteacher and read some documents written by her. Some indicators were identified to be able to detect during the observations, how teachers carried out their didactic activities.

For the first question, the indicators aimed at observing: the duration of frontal lessons; the use of new teaching methods (cooperative learning, individual activities, work in pairs, in large groups or between two groups-class), ICT and new furnishings; the use of alternative spaces depending on the activities to be offered to students (open space, classrooms, relaxation areas) and doing the schoolwork given by the teachers.

For the second question the indicators concerned: the flexibility of the furnishings, both in new schools where the furnishings had been chosen based on the activities to be carried out and in the old school where have the same old furniture; the ease reconfiguration of furnishings in new schools according to the activities proposed by teachers, the objectives and the needs of the students; the teachers' ability to "govern the spaces" in an expert manner and not "suffer them passively".

With the third question, through the observations and interviews, the reflections and perceptions of the teachers and the students were captured. The teachers were asked about the impact and effects of innovative learning environments in open space schools and about the space reorganisation with "readable subject classrooms" at Fermi Institute on: the students' learning and motivation; the teachers' work in terms of ease of use of the spaces according to the proposed activities; the collaboration among teachers for building the "bridge culture" and an educating community

The students in the open space school were asked if the innovative and very beautiful environments were: comfortable, motivating and useful to study better and socialise with schoolmates.

The students in the Italian schools with "readable subject classrooms" were asked if the new organisation, that expected their movement from one class to another, was positive and useful and allowed for a better use of school space and a better socialisation with schoolmates.

With regard to the last question for the Fermi Institute only, in addition to the headteacher interview questions were asked about the masonry work to build the TEAL classrooms, relaxation areas and spaces for individual study, and in the interviews to the teachers and students regarding the decoration of the subject classrooms to make them readable, the space changes were also detected with a survey using the school planimetry.

In terms of how the questions were addressed in the method, the first question "*How have teachers adapted their teaching to changing learning environments*?" was linked to observations conducted in each school. The teachers alternated short lectures with explanations or slides of school work given to the students, or programmed activities of cooperative learning. In the four schools the flexibility of the spaces allowed teachers to programme activities in an innovative way: in small groups, in large group with two or more classes, individually or even through new methodologies by the flipped classroom or other methodologies.

The second question "*What impact might new learning environments have on teachers and students*?", asked teachers to explain what happened between them. The new learning environments had "forced" them to collaborate with each other and to use with the students a more empathic and less formal relationship. The same happened with the interviews with the students: moving from one class to another, allowing greater socialisation, and a factor of re-motivation and pleasure in the study, as reported by the students interviewed.

The question "*How can the educational setting be changed for the personalisation of teaching and learning*?" highlighted the change that occurs in the setting of learning environments, the teachers change the setting depending on the use of different teaching methods that consequently allow to customise learning.

The last question "*How can learning environments be redesigned in old schools with limited investments*?", reflected the importance of highlighting that the fact that there are many old but functioning schools, and explored how to adapt them to new educational needs given that they cannot knocked down.

Results

Hellerup Skole and Ørestad Gymnasium

The teachers of Ørestad pointed out that the innovative architecture of the school and the new technologies "nurtured pedagogy and allowed the flexible and structured use of learning environments" [7]. At Hellerup and Ørestad there appeared to be on-going collaboration, facilitating new teaching strategies and collaborative lesson planning, resulting in the recognition of the students utilising different learning styles (Dunn & Dunn, 1978) [8]. Working closely together, the teachers of Hellerup shared their knowledge and skills available in a way that built a Peer Education modality among colleagues, as well as a mentality of sharing the materials produced, the teaching strategies used, and the potential to personalise both learning and teaching [9].

In both schools the open spaces meant teachers had to be very open minded and flexible because what one did was visible to everyone. It was an important aspect from a psychological point of view as it helped teachers support each other and share challenges. Teachers understood from the periodic tests and the results of the examinations that this organisation allowed students to learn more, better and with pleasure.

This developed a "bridge-culture" linking different levels (Sandrone, 2007), which was seen as a more sophisticated strategy than team teaching (where teachers meet in groups at predetermined times) (Bair & Woodward, 1964; Dean & Witherspoon, 1962). This bridge-culture also included structural and organisational components, and allowed teachers to overcome the fragmentation of disciplines and the lack of a unifying centre. According to students of both schools, the Cooperative Learning and Peer Education methods allowed rapid, personalised and informal learning, as theorised by Roger Cousinet (1952) [10].

To unpack this further, it should be noted the organisation of learning and teaching spaces can be found in pedagogical activisms theorised by John Dewey (1915), Maria Montessori (1921), Roger Cousinet (1952), Célestin Freinet (1946) and Loris Malaguzzi and Reggio Children (1998), and supported by new technologies [11]. Here, the students are closely monitored by teachers who stimulate their learning in different ways by trying to empower them in order to make them independent in their itinerary and aware of their own learning characteristics, leading to personal responsibility and a sense of meaning in their learning (Bonhoeffer, 1951). How this looks in practice is students being grouped by teachers, sometimes working in small groups, other times in large groups. This enhances socialising, learning to collaborate, recognising that young people learn quickly and efficiently when they work with a group of peers, and when they can take part in making decision on what goals they want to achieve and how (Gòrkiewicz, 2016). In terms of this translating to the physical environment, students are seen to be very good at interacting with the environment, adapting to spaces, using every corner, and making the school a place that feels like home (Volpicelli, 1964). In the school structures in this study, they appear to feel totally free to choose the place where to study and move and they think an open space "broadens the spaces of the mind" [12].

In both schools, students are not considered as a homogenous mass, but as unique and original individuals, which reflects the concept of the Danish pedagogist Nicolai F. S. Grundtvig (De Natale, 1980). In order to teach in these schools, it is imperative to believe in the pedagogical project and work closely with colleagues at multiple levels since this sparks a strong synergy among them. Consequently, design flexibility that is aligned to these pedagogic principles allows students to leave the traditional "isolation and control school, governed by authoritarian transmitters of closed and undisclosed knowledge" (Iori, 1996, p. 120). There is a flow of informal exchange between teachers and students, creating a collaborative atmosphere and educational community.

Enrico Fermi Institute and IC3 Piersanti Mattarella

In Italy the new organisation of learning spaces by switching to "Readable Subject Classrooms" and TEAL classrooms obliged teachers to revise their teaching methods. Traditional frontal teaching was reduced, and new methodologies introduced such as Cooperative Learning, Debate and EAS (Episodi di Apprendimento Situato—Located Learning Episodes) (Rivoltella, 2016) [13]. The use of new technologies allowed teachers to bring the "school to children's rooms" [14].

The teachers of both schools appreciated the opportunity to share the classroom with their colleagues because they had their material available without having to move continuously from one classroom to another [15]. Again, this modality created the bridge-culture referred to earlier in this chapter. The drawback was the lack of informal exchange with the colleagues of the same class. Teachers helped by students personalised their classrooms and it allowed them to better enhance the creativity of the students and to keep the rooms beautiful and tidy (Fianchini, 2017).

Teachers agreed, however, that new teaching methods increased the students' attention and motivation, and enhanced positive learning, learning behaviours and discipline management [16].

In the interviews students appeared thrilled because they could move from one classroom to another at the change of a lesson, and allowed for a break of "decompression" and an increase in relational exchange and socialisation with students of other courses [17]. The classrooms became "readable" because the students could personalise them with their teachers. Students claimed they were enthusiastic to go to school because they found it to be a comfortable, familiar environments where they learned without anxiety. It was, they claimed, an environment that made them feel comfortable, being "the fuel of motivation" [18].

The same was found at IC3 Mattarella school. The possibility of using flexible spaces allowed changes to the physical classroom setting and the capacity to propose different organisational solutions and teaching methods [19]. Thus, space became "…a pure form of intuition that anticipates every representation of sensibly given objects" (Heidegger, 1996, p. 29). In this school at the time of the research every teacher had their own classroom, but in upcoming years, the intention was the teachers had to share their classrooms, due to increasing students number from 180 students to about 300 [20].

The student lockers were very important because they represented a place of meeting, exchange and socialisation [21], as well as a symbolic space; a kind of nest that was immediately associated with the image of the house (Bachelard, 1957). These were seen as an intimate space and also a "vital space" (Lewin, 1936), where, behind the objective vision, there was the vision "of the imaginary" (Moles & Rohmer, 1982).

Discussion

Looking closely at how the organisation of learning spaces interacts with the didactics (pedagogy) of teaching, it is possible to identify the pedagogical activism of John Dewey, Maria Montessori, Roger Cousinet, Célestin Freinet and Reggio Children. The structure of an environment in a rigid and disciplined way can be considered an artificial device which, acting on the student, "forces him to operate and behave in a certain way" (Bertagna 2010, p. 301). Changing learning environments requires a change in methodology to personalise teaching and learning, so a very important factor is how teachers think about their teaching role in the new learning spaces. Hattie and Zierer (2018) have defined ten mental frames or behaviours that teachers should adopt to maximise student success. In essence, the quality of professional action depends on critical reflection on professional practices, so as to constantly, consciously and critically modify one's actions, and innovative learning environments help the teacher to reflect on their teaching practices (Schön, 1983).

Data collected for this project in selected progressive schools where a symbiosis exists between special design and teaching practices, puts the teachers as proponents of a new vision of "doing schools". Here, teaching and learning are increasingly placed within a dimension of collective practice that builds together shared social meanings (Zuccoli, 2017) to make the school a real third educator. Therefore, the professionalism of the teacher and his or her actions between theory and practice are in a constant dialectic relationship: the teachers' reflection on her or his actions can help them become aware of their tacit professional practice so as to place them in a critical analysis of their actions and to intervene promptly when difficulties arise. The idea of reflective practice "leads to new conceptions of the relationship between teacher and pupil and would certainly lead to an improvement in professional practice" (Schön, 1983, p. 336).

Artificial, natural, biological, family or community devices can be considered as a set of practices able to capture, orient, determine, intercept, model, control and ensure not only gestures and behaviours, but also opinions, beliefs, discourses, and meanings expressed by "human beings". Each device acts and plays a decisive role, albeit with different modes and forces depending on the situation, in subjecting the people who are born to the already existing and established natural, technical, artificial, family and community rules and balances of such institutions. However, it is possible the teacher's role is emptied of emotional contents because it ends up becoming "teaching without saying anything about oneself, complaining of a too superficial and passive listening on the part of the students who retire at the margins of the formative process" (Gamelli, 2001, p. 110).

The school spaces are not only the places of “teaching practice”, but are “places of life” in which one establishes “educational relationship” and “existential relationship” (Gennari, 1988; Iori, 1996). For these reasons it is very important that the school spaces are beautiful, where students and teachers feel well, in serenity and well-being (Iavarone, 2008; Avalle, 2009). In fact, neuroscience research tells us that space and objects presented in an environment are mapped by our body that physiologically and emotionally empathises with the surrounding environment through mirror neurons and then coded through the sense-motor, emotional and hedonic circuits and only then we have the positive or negative awareness of our experience (Gallese, 2013; Gallese & Gattara, 2015; Mallgrave 2013).

All these experiences remain in our emotional memories through emotional short circuits. A mechanism of connection between cognitive and emotional aspects is regulated by the amygdala. If, while learning, we have positive emotions, we will easily and with pleasure remember what we have learned, but if learning is linked to painful memories, the suffering linked to that negative situation will emerge in the memory because, with this information negative emotions are also coded (Goleman, 1995).

The amygdala manages the basic emotions and it is the archive of emotional memory, in situations of anxiety and fear stimulates the escape, even from memory. An educational caress and a feeling of well-being command the production of neurotransmitters in the hypothalamus linked to the oxytocin hormone that regulates anxiety and produces feelings of well-being. For this reason, it is necessary to associate positive feelings when learning because only in this way the memory will be pleasant (Ledoux, 1996; Lucangeli, 2017).

In learning environments that are pedagogically focused but also designed to be beautiful and with flexible furnishings that meet and educational needs of students, everyone feels recognised, supported, appreciated and valued. Students feel good and this improves study and school performance (Barret et al., 2015; Horne-Martin, 2002, 2006). In a new organisation of learning environments with an idea of school as a third teacher, the classroom can be thought of as a backstage of theatre and the teacher as an educational director who can propose a new didactic model with a plurality of proposals that can stimulate learning personal itineraries (Gamelli, 2001; Rivoltella, 2012).

According to Rivoltella, “teaching is technology of performance” (2012, p. 159) and there are two instances that link the text to teaching. The first concerns the text intended as a lesson or laboratory activities that must be programmed according to a precise scheme, as a theatrical or cinematographic script; the second is related to the text intended as a “textbook” or other medium that serves the teacher in his own didactic action.

In these schools the perspective has been inverted compared to the past in which the teacher was at the centre of the teaching-learning process; it is now necessary to focus on the student and on her or his educational dimension, through appropriate educational choices that are in relation to his or her real educational needs.

The design of an educational environment represents the process of attributing meaning to environments, defined as “semantotopic” (Franceschini & Piaggesi, 2000,

p. 55). In order to design a physical space, that is, a “topical text”, the designers and the beneficiaries of the space must share the same meaning as well as refer to semantics. The environments offer “affordances” (Gibson, 1979, p. 205), which is a kind of “invitation” through the existing objects that guide actions. The environmental organisation acts in an invisible way through the “invisible” (Bernstein, 1979, pp. 192–224) or “latent pedagogy” (Bondioli, 2008, p. 14) which is passively accepted and experienced by teachers.

This chapter uses data from four exquisite schools to emphasise fundamental concepts that guided the design and/or reorganisation of the spaces: readability, flexibility, semantotopics, affordance and invisible or latent pedagogy. The readability of the spaces refers to the possibility of categorising and recognising them immediately through certain elements that allow their orientation (Kaplan, 1987; Lynch, 1960). There must be an “intrinsic flexibility or actual variety” that is what architects call “built-in-flexibility” (De Bartolomeis, 1983, pp. 188–94). And these qualities must be measurable (Imms, Cleveland, & Fisher, 2016).

Conclusion

Célestine Freinet claims that, if modernisation is made possible in the classrooms and learning spaces, it is also possible to modernise teaching (Freinet, 1946). In the schools presented in this chapter, learning environments and new technologies are seen to help teachers to modify teaching. But not all teachers take advantage of their potential. The temporal quality of change may be the key—time may allow some teachers to use these new environments in positive ways and move away from the certainty of established practices (Imms, 2016b). This step is complex because it does not represent an adjustment of methodologies, but a total transformation that challenges every aspect of the system: from identifying the roles that are played within the school (Osborne, 2016), to the duration of the lessons that would be less fractionated. Time and space go hand in many circumstances and they are assimilated by expressions such as “measure”, “distance”, “interval” that are applied to both (Minkowski, 1968); for this reason, changing the spaces means it also becomes almost necessary to modify and merge the way we address timetabling in schools.

The innovative structure of learning environments with the high-tech classroom and “variable geometry” settings (Ferri, 2011) has allowed the introduction of new teaching methodologies and learning personalisation. In the four schools presented in this chapter, the students agreed that teachers were not always expert in technologies, nor in arbitrating types of learning.

It becomes important to start from the space, its organisation and new technologies in order to propose a new teaching model where at the centre there is no longer the teacher but the learner, as the conscious protagonist of his own learning. Teacher adaptation to new learning environments requires changing teaching practices because the knowledge must be constructed by the learner (Jonassen & Land, 2012). Success will be more likely if headteachers build change processes, adopt a leadership style appropriate to the context and engage in participatory planning, problem solving and promoting the creation in the teachers a sense of utility (Osborne, 2016).

In this study some categories have been identified in a way that they describe pedagogical facts, opinions and behaviours representing the meaning they expressed. Although the results of this study cannot be generalised, they represent a useful point of specific analysis of pedagogical architecture and heuristic value for any subsequent investigation. "Pedarchitecture" seems to be the right word to highlight the link between pedagogy and the architecture of learning spaces.

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Data utilised in this research was obtained in adherence to the required ethical protocol of the author's host institution. All images and diagrams are the property of the author, or the author has obtained consent to use them from the appropriate copyright owner.

Endnotes

[1] Hellerup—observation protocol.
[2] Hellerup—pedagogical project: https://hellerupskole.aula.dk/ last visit 10.04.20.
[3] Ørestad—rector's protocol interview and information on: https://www.oerestadgym.dk/in-english/about-oerestad-gymnasium/ and https://www.youtube.com/watch?v=dEla4CltzmI last visit 10.04.20.
[4, 5] Ørestad—rector's protocol interview and pedagogical project: https://www.oerestadgym.dk/in-english/about-oerestad-gymnasium/ last visit 10.04.20.
[6] Fermi—headteacher's protocol interview.
[7] Ørestad—teachers' and rector's protocol interviews and information on: https://www.oerestadgym.dk/in-english/out-teaching/ last visit 10.04.20.
[8] Hellerup and Ørestad—teachers' protocol interviews.
[9] Hellerup—observation protocol.
[10] Hellerup and Ørestad—students' protocol interviews.
[11] Hellerup and Ørestad—observation protocols.
[12] Ørestad—students' protocol interview.
[13] Fermi—observation protocol.
[14] Fermi—headteacher's protocol interview.
[15, 16] Fermi and Mattarella—teachers' protocol interviews.
[17, 18] Fermi students' answers to protocol interview.
[19] Mattarella—observation protocol.
[20] Mattarella—teachers' protocol interview.
[21] Mattarella students' protocol interview.

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References

AA.VV. (2012). *Jubilæumsskrift. Hellerup Skole 10 ÅR. Den 20.* September 2012. Gentofte Kommune: Gentofte.

Arendt, H. (1961). *Between past and future six exercises in political thought*. New York: Viking Press.

Armenakis, A. A., Harris, S. G., & Mossholder, K. W. (1993). Creating readiness for organizational change. *Human Relations, 46*(6), 681–704.

Avalle, U. (2009). *Il ben essere a scuola*. Milano: Bruno Mondadori.

Bachelard, G. (1957). *La poétique de l'espace*. Paris: Presse Universitaires de France.

Bair, M., & Woodward, R. G. (1964). *Team teaching in action*. Boston: Houghton Mifflin Company.

Barret, P., Zhang, Y., Davies, F., & Barret, L. (2015). *Clever classrooms*. Manchester: University of Salford.

Bernstein, B. (1979). Classi e pedagogie: visibili e invisibili. In E. Becchi (Ed.), *Il bambino sociale*. Milano: Feltrinelli.

Bertagna, G. (2006). Pedagogia dell' "uomo" e pedagogia "della persona umana": il senso di una differenza. In G. Bertagna (Ed.), *Scienze della persona perché*? (pp. 17–74). Soveria Mannelli, CZ: Rubbettino.

Bertagna, G. (2010). *Dall'educazione alla pedagogia. Avvio al lessico pedagogico e alla teoria dell'educazione*. Brescia: Editrice La Scuola.

Bertagna, G. (2012). Individualizzazione e personalizzazione una rilettura pedagogica. In A. Antonietti & P. Triani (Eds.), *Pensare e innovare l'educazione. Scritti in memoria di Cesare Scurati*. Milano: Vita & Pensiero.

Bondioli, A. (2008). Un dispositivo per l'analisi e la valutazione dell'organizzazione pedagogica della scuola dell'infanzia (DAVOPSI). In A. Bondioli & G. Nigito (Eds.), *Spazi, tempi, raggruppamenti. Un dispositivo di analisi e valutazione dell'organizzazione pedagogica della scuola dell'infanzia (DAVOPSI)* (pp. 115–257). Azzano S. Paolo, BG: Edizioni Junior.

Bonhoeffer, D. (1951). *Widerstand und Ergebung*. München: Chr Kaiser Verlag.

Byers, T., Imms, W., & Hartnell-Young, E. (2014). Making the case for space: The effect of learning spaces on teaching and learning. *Curriculum and Teaching, 29*(1), 5–19. https://doi.org/10.7459/ct/29.1.02.

Coèn, R. (1965). *Ambiente e educazione*. Firenze: La Nuova Italia.

Collins, A. (1991). Cognitive apprenticeship and instructional technology. In L. Idol & B. F. Jones (Eds.), *Educational values and cognitive instruction: Implications for reform* (pp. 121–138). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Cousinet, R. (1952). *Une méthode de travail libre par groupes*. Paris: Éditions du Cerf.

De Bartolomeis, F. (1983). *Le attività educative: organizzazione, strumenti, metodi*. Roma: La Nuova Italia.

De Natale, M. L. (1980). *L'educazione per la vita. N.F.S. Grundtvig pedagogista ed educatore danese*. Roma: Bulzoni.

Dean, S. E., & Witherspoon, C. F. (1962). *Team teaching in the elementary school. Education Briefs, 38*, 4 (Office of Education, Division of State and Local School Systems, Instruction, Organization and Services Branch).
Dent-Read, C., & Zukow-Goldring, P. (1997). Introduction: Ecological realism, dynamic systems approaches to development. In C. Dent-Read & P. Zukow-Goldring (Eds.), *Evolving explanation of development: Ecological approaches to organism-environments systems*. Washington DC: American Psychological Association.
Dewey, J. (1915). *The school and the society*. Chicago: The University of Chicago Press.
Dori, Y. J., & Belcher, J. (2005). How does technology-enabled active learning affect undergraduate students' understanding of electromagnetism concepts? *The Journal of the Learning Science, 14*(2), 243–279.
Dunn, R., & Dunn, K. (1978). *Teaching students through their individual learning styles*. Reston: A Prentice Hall Company.
Edwards, C., Gandini, L., & Forman, G. (Eds.). (1998). *The hundred languages of children: The Reggio Emilia approach advanced reflections*. Connecticut: Greenwood Publishing Group.
Faiferri, M. (2012). La scuola come metafora del mondo. *Domus*. https://www.domusweb.it/it/architettura/2012/09/21/la-scuola-come-metafora-del-mondo.html. Last visit April 10, 2020.
Ferri, P. M. (2011). I nativi digitali e i personal media. In M. Mincu (Ed.), *A ciascuno la sua scuola. Teorie, politiche e contesti della personalizzazione*. Torino: SEI.
Fianchini, M. (2017). Modelli autoorganizzati di miglioramento nell'uso degli ambienti scolastici. In M. Fianchini (Ed.), *Rinnovare le scuole dall'interno. Scenari e strategie di miglioramento per le infrastrutture scolastiche* (pp. 113–123). Sant'Arcangelo di Romagna, RN: Maggioli.
Foucault, M. (1975). *Les corps dociles. Surveiller et punir. Naissance de la prison*. Paris: Gallimard.
Franceschini, G., & Piaggesi, B. (2000). *La progettazione degli spazi nella scuola dell'infanzia: un percorso di studio e ricerca-azione*. Milano: Franco Angeli.
Freinet, C. (1946). La Coopération à l'Ecole Moderne. *Brochure d'Education Nouvelle Populaire*. N. 22.
Gallese, V. (2013). Foreword. In H. F. Mallgrave. (2013). *Architecture and embodiment. The implications of the new sciences and humanities for design*. London: Routledge.
Gallese, V., & Gattara, A. (2015). Embodied simulation, aesthetics, and architecture: An experimental aesthetic approach. In S. Robinson & J. Pallasmaa (Eds.), *Mind in architecture. Neuroscience, embodiment and the future of design* (pp. 161–79). Cambridge, MA: The MIT Press.
Gamelli, I. (2001). *Pedagogia del corpo. Educare oltre le parole*. Roma: Meltemi.
Gardner, H. (1993). *Multiple intelligences: New horizons in theory and practice*. New York: Basic Book.
Gennari, M. (1988). *Pedagogia degli ambienti educativi*. Roma: Armando.
Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin Company.
Goleman, D. (1995). *Emotional intelligence*. New York: Bantam Books.
Gòrkiewicz, K. (2016). Social and cultural learning environments. In *Educational Spaces 21*. Open up! (Vol. 3). Warsaw.
Hall, E. T. (1959). *The silent language*. New York: Doubleday.
Hattie, J., & Zierer, K. (2018). *10 mindframes for visible learning. Teaching for success*. London and New York: Routledge.
Heidegger, M. (1996). *Bemerkungen zu Kunst – Plastic – Raum*. Erker: Verlag.
Hopkins, D. (2008). Introduzione all'edizione italiana. In AA. VV. *Personalizzare l'insegnamento* - CERI- OCSE. 9–11. Bologna: Il Mulino. Or. tit.: (2006). *Personalising Education/Personaliser l'éducation*. Paris: Organisation for Economic Co-operation and Development.
Horne-Martin, S. (2002). The classroom environments and its effect on the practice of teacher. *Journal of Environmental Psychology, N. 221-2,* 139–156.

Horne-Martin, S. (2006). The Classroom environment and children's performance-is there a relationship? In C. Spencer & M. Blades (Eds.), *Children and their environments*. Cambridge: Cambridge University Press.
Hoz, V. G. (1988). *Educación personalizada.* Madrid: Rialp.
Kotter, J. P. (1996). *Leading change*. Boston, MA: Harvard Business Press.
Iavarone, M. L. (2008). *Educare al benessere*. Milano: Bruno Mondadori.
Imms, W. (2016a). Occupying curriculum as space. In K. Fisher (Ed.), *The translational design of schools. An evidence-based approach to aligning pedagogy and learning environments* (pp. 145–155). Rotterdam: Sense Publishers.
Imms, W. (2016b). New generation learning environments: How can we find out if what work is working? In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Evaluating learning environments: Snapshots of emerging issues, methods and knowledge* (pp. 21–34). Rotterdam: Sense Publishers.
Imms, W., Cleveland, B., & Fisher, K. (2016). Pursuing that elusive knowledge about what works in learning environment design. In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Learning environments evaluation. Snapshots of emerging issues, methods and knowledge* (pp. 3–16). Rotterdam: Sense Publishing.
Iori, V. (1996). *Lo spazio vissuto. Luoghi educativi e soggettività.* Firenze: La Nuova Italia.
Juelkjær, M. (2012). School architecture and learning conditions, a Danish case. *Jianzhu Jiyi,* 69–71.
Jonassen, D., & Land, S. (Eds.). (2012). *Theoretical foundations of learning environments*. New York, London: Routledge.
Kaplan, S. (1987). Aesthetics, affect, and cognition: Environmental preference from an evolutionary perspective. *Environment and Behavior, 19*(1), 3–32.
Ledoux, J. (1996). *The emotional brain. The mysterious underpinnings of emotional life*. New York: Simon & Schuster.
Lewin, K. (1936). *Principles of topological psycology*. New York: McGraw-Ill Book Company Inc.
Lippman, P. C. (2010). *Evidence-based design of elementary and secondary schools: A responsive approach to creating learning environments*. New Jersey: Wiley.
Lucangeli, D. (2017). *Emotional short-circuits: The intelligence behind mistakes*. TEDx Milano. https://www.youtube.com/watch?v=QuC52IoTczY. Last visit April 10, 20.
Lynch, K. (1960). *The image of the city* (Vol. 11). Cambridge, MA: The MIT Press.
Mallgrave, H. F. (2013). *Architecture and embodiment. The implications of the new sciences and humanities for design*. London: Routledge.
Maritain, J. (1943). *Education at the crossroads*. New Haven: Yale University Press.
McGrane, S. (2012, January 18). Open spaces transform Danish education. *The Wall Street Journal.* https://www.wsj.com/articles/SB10001424052970204555904577168592091278750. Last visit April 10, 20.
Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass Publishers.
Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*. Thousand Oaks: Sage Publications.
Miliband, D. (2006). Policy strategies to enhance the personalised learning agenda. In CERI. *Personalising education*. Paris: OECD.
Minkowski, E. (1968). *Le temps vécu: études phénoménologiques et phychopathologiques*. Neuchâtel: Delachaux et Niestlé.
Moles, A., & Rohmer, E. (1982). *Labyrintes du vécu. L'Éspace matière d'actions*. Paris: Libraire des Méridiens, Klincksiec&C[ie].
Montessori, M. (1921). *Manuale di pedagogia scientifica*. Napoli: A. Morano.
Mortari, L. (2012). *Cultura della ricerca e pedagogia. Prospettive epistemologiche*. Roma: Carocci.
Mounier, E. (1935). *Révolution personnaliste et communautaire*. Paris: Aubier.
Nair, P., & Fielding, R. (2005). *The language of school design: Design patterns for 21st century schools*. Minneapolis: Designshare.
OECD. (2009). *Creating effective teaching and learning environments*, first results from TALIS. http://www.oecd.org/education/school/43023606.pdf. Last visit April 10, 20.

Osborne, M. (2016). What works. Changing practice when spaces change. In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Evaluating learning environments: Snapshots of emerging issues, methods and knowledge* (pp. 35–43). Rotterdam: Sense Publishers.
Pavan, A. (2003). Dai personalismi alla persona. In A. Pavan (Ed.), *Dire Persona* (pp. 19–34). Bologna: Il Mulino.
Ricoeur, P. (1983). Meurt le personnalisme, revient la personne. *Esprit* (1940), *73*(1), 113–119.
Rivoltella, P. C. (2016). *Che cos'é un EAS. L'idea, il metodo, la didattica*. Brescia: Editrice La Scuola.
Rivoltella, P. C. (2012). *Insegnare al cervello che apprende*. Milano: Raffaello Cortina.
Romanini, L. (1962). *Costruire scuole*. Milano: Garzanti.
Rousseau J. J. (1762). *Èmile ou De L'éducation*. La Haye: Chez Jean Néaulme Libraire.
Ruini, C. (2009). Prefazione. In CEI. *La sfida Educativa*. Bari: Laterza.
Sandri, P., & Marcarini, M. (2019). The teachers' and students' perceptions about inclusion through innovative learning environments. In W. Imms & M. Mahat (Eds.), *What are teachers doing (well) when transitioning from traditional classrooms to innovative learning environments? Proceeding of International Symposia for Graduate and Early Career Researchers in Australasia, Europe and North America*. http://www.iletc.com.au/publications/proceedings. Last visit April 10, 20.
Sandrone, D. G. (2007). *La cultura assente. Un'indagine sul tema « Professione docente e "cultura ponte"*. Soveria Mannelli, CZ: Rubbettino.
Sandrone, G. (2010). Introduzione. In G. Sandrone (Ed.), *Educazione e ricerca: problemi, profili, modelli*. Soveria Mannelli, CZ: Rubbettino.
Santoianni, F. (2010). *Modelli e strumenti di insegnamento. Approcci per migliorare l'esperienza didattica*. Roma: Carocci.
Schön, D. A. (1983). *The reflexive practitioner*. New York: Basic Books Inc.
Sergiovanni, T. J. (1994). *Building community in schools*. San Francisco: Jossey-Bass Inc., Publisher.
Silverman, D. (2000). *Doing qualitative research: A practical guide*. London: Sage.
Staff of Hellerup Skole. (2012, September). *Det ny Springbræt*. Gentofte: Hellerup Skole.
Trinchero, R. (2002). *Manuale di ricerca educative*. Milano: Franco Angeli.
Undervisningsministeriet-UVM. (1999). *Folkeskolerådets debatoplæg fra 2000* '*Vision 2010 – en udviklingssamtale med skolen*'. http://static.uvm.dk/publikationer/2000/vision/hel.htm. Last visit April 10, 20.
Vindum, K. (2007). A misura di bambino/On childrens scale: Due scuole di Arne Jacobsen/Two schools by Arne Jacobsen. *Casabella*. N. 750/751.
Volpicelli, L. (1964). *Educazione contemporanea: aspetti e problemi* (Vol. II). Roma: Armando.
Vygotsky, L. S. (1980, 1962). *Thought and language*. In E. Hanfmann & G. Vakar (Eds.). Chicago: The MIT Press.
Woolner, P. (2010). *The design of learning spaces*. London: Continuum International Publishing Group.
Woolner, P. (Ed.). (2015). *School design together*. New York: Routledge.
Yin, R. K. (2003). *Case study research: Design and methods, applied social research methods*. Thousand Oaks: Sage.
Zuccoli, F. (2017). Un ambiente che può essere gabbia o stimolo. Le voci e le riflessioni dei docenti. In M. Fianchini (Ed.), *Rinnovare le scuole dall'interno. Scenari e strategie di miglioramento delle infrastrutture scolastiche* (pp. 67–77). Sant'Arcangelo di Romagna, RN: Maggioli.

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Using Fällman's Interaction Design Research Triangle as a Methodological Tool for Research About Reading Spaces in Schools

Emma Dyer

Abstract This chapter describes the innovative use of a pre-existing framework from the field of Human–Computer Interaction to explore and reimagine reading spaces for beginner readers in primary schools in England. The chapter details the four phases of the research study, from a conceptual level to a physical outcome (a reading nook), the latter providing secondary findings about the value of secluded reading spaces for students in two English classrooms. In adapting and developing a design methodology within an educational context, it is hoped that this research will stimulate communication and dialogue between architects, educators, policy-makers and students. It also offers a contribution to the challenge of improving school design for pupils and practitioners by offering a framework through which education, specifically reading, can be viewed through the prism of design.

Introduction

The curriculum, the rule book, the head teacher's policy, the staff hierarchy, the punishment regime and other socially prescribed matters may appear to exert a far stronger influence on the way a school works, but the spatial setting is nevertheless ever present and never neutral, for it always makes some patterns of use easier and others more difficult. We become blind to this once habituated in the use of a building, for it seems just to be there, and we have to make an imaginative leap to envisage how it might be otherwise (Blundell Jones, 2014, p. 13).

In this short extract from a chapter about the historical development of the school building and the articulation of territory, the architect and academic Peter Blundell Jones reminds us how significant but also how easily overlooked the role of spatial setting is in schools. In this chapter, I describe how I adapted a framework from the field of Human–Computer Interaction (HCI) to document and record a particular type of unattended-to space in school: those where young children learn to read. Blundell Jones suggests that an imaginative leap needs to be made in order to re-envisage

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forgotten spaces like these but taking such a creative leap is not easy and requires support and inspiration. Here, I demonstrate how I was supported in this through this HCI framework; how this resulted in new knowledge about beginner readers in school; and how this led to the development of a tangible, physical reading space for young children.

This methodologically innovative framework was originally developed by Daniel Fällman in collaboration with his colleagues at the Umeå Institute of Design in Sweden. The framework, described explicitly in Fällman's 2008 paper *The Interaction Design Research Triangle of Design Practice, Design Studies, and Design Exploration*, reflects the complex and interactive nature of design research while maintaining a strong focus on the relationship between design and the end-user. Throughout this chapter, I use the example of my doctoral research about the relationship between inexperienced readers and the school environment to show how this framework can be used to reimagine spatial settings and practices in school buildings. However, since this study was completed, I have begun to investigate the design of therapeutic spaces in schools, where children might receive counselling or therapies, using the same framework.

In exploring the use of this methodology, my doctoral research benefited from a collaboration with an architecture practice, SCABAL and an industrial partner, Jenx. These partnerships enabled me to realise a level of design that would not have been possible without their insight and support.

The Methodological Framework

Figure 1 shows a simplified version of a diagram from Fällman's 2008 paper that gives an overview of his framework. It consists of three non-hierarchical elements or activities: design studies; design practice and design exploration, each of which has a distinct character. *Design studies* is a discipline familiar to academic researchers, necessitating a comprehensive, multi-disciplinary review of the literature, but it also requires precedents of design innovations to be reviewed. *Design practice* brings matters of budget, materials, time, communication with stakeholders and other real-world problems into the equation, while *design exploration* asks "What if…?", prompting the researcher to imagine benefits to the individual end-user and to society at large through experimentation and subversion of objects and practices that are taken for granted and habituated.

The separation of these three elements of design into their triangular formation with a single element at each vertex allows the researcher to choose which combination of two elements of design research they wish to explore at any one time. By isolating one element, the researcher is free to explore the remaining two research activities that may be compromised or complicated by the third. For example, when moving between design studies and design exploration, the researcher can explore new designs and draw on existing precedents without having to focus on the practicalities of the available budget or suitable materials. As there is no prescribed order

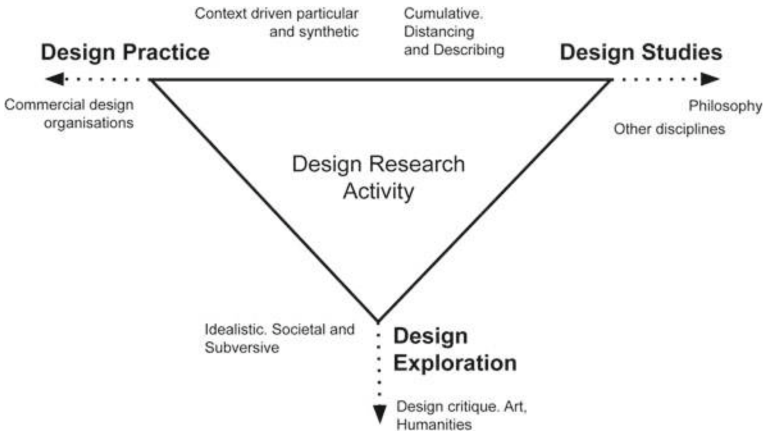

Fig. 1 An overview of Fällman's interaction design research triangle of design practice, design studies, and design exploration *Source* Daniel Fallman, 'The interaction design research triangle of design practice, design studies, and design exploration', Design Issues, 24:3 (Summer, 2008), pp. 4–18. © 2008 by the Massachusetts Institute of Technology

for using the framework, the researcher can move between activities as they see fit and at their own pace. The only stipulation for using the framework is that one outcome of the research process must be a designed artefact. This may be virtual or physical.

Three Initial Research Phases

The use of the conceptual research model from the field of Human–Computer Interaction (HCI) highlights the interaction and the interdependence between the physical, sensory requirements of the pupil in school and their surroundings. Literacy education in schools has commonly accorded little importance to the bodily and emotional needs of the novice reader but, as Mayall, Bendelow, Barker, Storey and Veltman remind us, "[c]hildren bring their bodies and emotions to school every day not just their minds" (1996, p. 1). In my study, the body and emotions of the beginner reader were carefully considered through the design of an artefact, a child-scaled classroom reading space, known as a *nook*.

Edgerton, McKechnie and McEwen argue that "in assessing the impact of education, researchers have tended to focus on what is taught or how it is delivered. Limited attention has been paid to *where* pupils learn" (2011, p. 34, emphasis added). This prompted the first of two research questions, "Where do beginner readers read in the contemporary English, mainstream primary school?" This question identified a gap in knowledge about the types of spaces where beginner readers read in school and the qualities of those spaces. My second research question, "Where could beginner

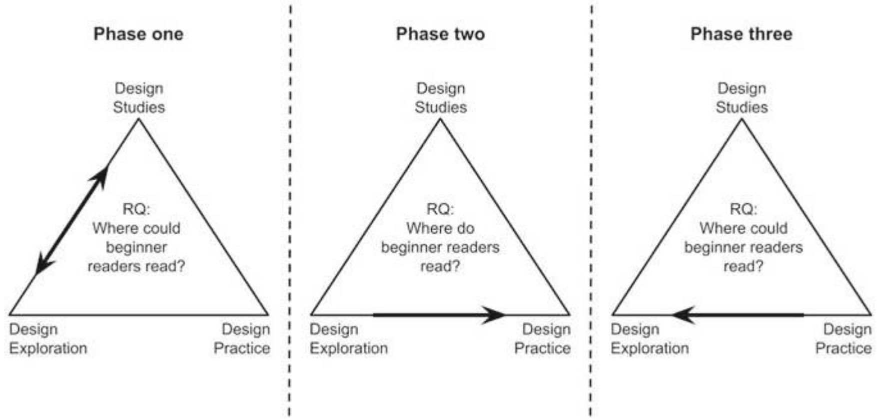

Fig. 2 Three phases of Fällman's triangular model

readers read in the contemporary English, mainstream primary school?", addressed a propositional design approach, emphasising the complex interaction between the body of the reader and the environment in which they read.

Figure 2 illustrates the way in which I used Fällman's triangular model to frame my study with the arrows demonstrating the direction of the research. Phase one and three were imaginative interpretations of academic and empirical research while the latter was the focus of phase two. Figure 3 maps how the methodology guided the specific activities undertaken during my doctoral research as a whole and includes a fourth, post-doctoral research phase that I describe briefly at the end of this chapter.

Phase One: Design Studies and Design Exploration

Phase one of the study entailed assembling a rich body of relevant academic research and precedents to use when designing a propositional reading space. This initial research was inspired by my work as a Reading Recovery teacher in a London (UK) district notable for social and economic deprivation which had prompted me to consider the vital importance of the school building for children who have little space, attention or comfort in their own homes. My pedagogical, spatial and emotional experiences of teaching reading with children aged five and six were poorly represented in the literature of reading and literacies or that of school design, leading me to identify a significant gap that needed to be explored further. Although I encountered many excellent articles dedicated to a developmental analysis of inexperienced readers, there was little acknowledgement in the literature as a whole that inexperienced readers are more dependent upon a supportive physical environment while they learn to read than fluent readers or that the body of the reader is a significant aspect of reading. Despite this absence of scholarship about the spaces where

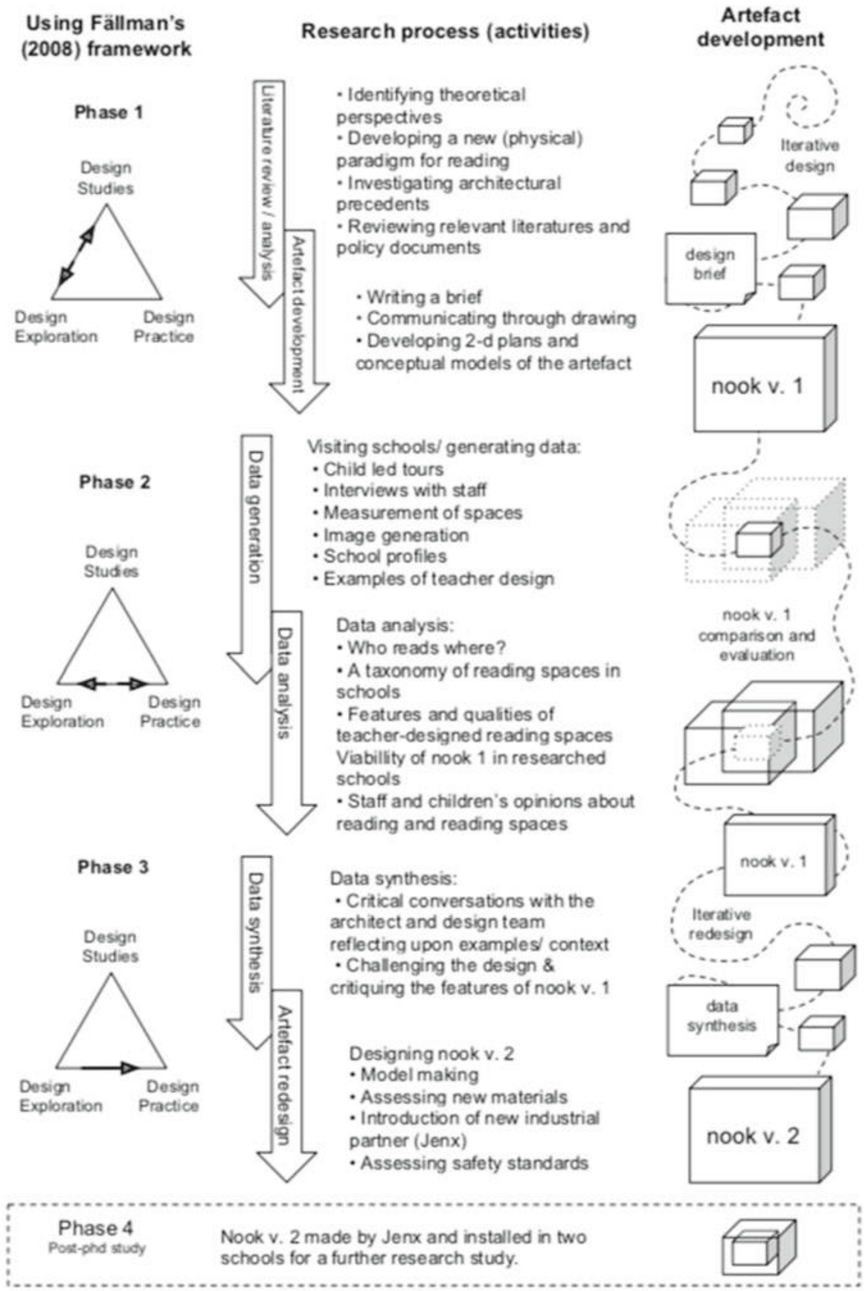

Fig. 3 Phases of research

beginner readers read and of the reading body, I discovered several useful texts about aspects of reading that, when applied to beginner readers, helped me to build a picture of their needs within the school environment. I then examined the current reading curriculum and system of assessment for reading and standards for the design of school buildings with respect to qualities of design, such as acoustics, that might adversely affect beginner readers, who generally learn to read in school by reading aloud. Although I had difficulty in finding any examples of spaces in schools that had been designed specifically by designers and architects for beginner readers, I found examples of design for quiet, nurturing spaces in schools and library spaces that, while not specifically attending to the needs of beginner readers, were well-designed to accommodate all readers.

Fällman's framework, having been developed to aid Ph.D. students in his department, also supported a more traditional approach to doctoral research in this phase of the framework by supporting the development of a comprehensive literature review that identified three significant gaps in scholarship relating to reading and spatial settings:

– The relationship between reading pedagogies, practices and routines and the spatial arrangements inside and beyond the classroom for beginner readers
– A conceptualisation of reading in relation to the physical body of the beginner reader in school
– The current practice of designing reading spaces by teaching staff in primary schools.

The requirement of the framework to explore design studies in tandem with the second element of the framework (here, design exploration) led to an investigation in this phase of how readers might respond to the physical environment of the school building and how they use their bodies to read. Reading demands a high level of concentration and when this has not yet been habituated, non-fluent readers are often easily distracted and prey to interruption. They also rely on good acoustics to distinguish between the sounds (phonemes) being taught to them by their teachers and to relate these to the letters (graphemes) that they are learning. Despite this, it appears that school buildings are often poorly designed for novice readers, who often learn in open, noisy spaces with challenging acoustics. Scholars of reading often take for granted the assumption that the body of the fluent reader is absent, cocooned and unaware, whereas my own theoretical perspective of reading, influenced by the phenomenological texts of Merleau-Ponty, draws on a conception of reading as physical and sensory, as expressed very powerfully by McLaughlin in *Reading and the Body* (2015). Having contextualised my own understanding of fluent reading as a physical, bodily activity during which the reader learns to habituate and conceal the physicality of the experience to themselves in order to promote full concentration upon the text, I extrapolated the qualities that differentiate expert readers from beginner readers. I then sought precedents of reading spaces inside and beyond the school building that could compensate for the differences between experts and beginners, primarily attending to the vulnerability of beginner readers to unwanted distraction and interruption within the school building. These precedents formed the basis of the first design of the nook.

The design studies element of Fallman's framework prompted a review of the literature of how reading is taught in English schools and of policies relating to the reading curriculum and to assessment. This provided rich, contextual information that supported the design of a reading artefact. I found that a dominant paradigm for the teaching of reading in contemporary English primary education had become increasingly strong since a change of government in 2010. Fundamental to this paradigm is a programme of synthetic, systematic phonics. In the first year of formal education, Year One, when students are five or six years old, the *reading ability* of all students is assessed by a statutory, national pass or fail examination. Every child in school in England must pass this test or retake it in the following year(s) until they do pass, with few exceptions made for children with special educational needs. Schools that administer the test incorrectly can be reported to the national maladministration hotline and their status as a school may also be under threat. Any physical, material designs for reading activities and for readers in the primary education system in England therefore needs to take account of this model and delivery of the teaching of reading. Although I disagree with this cognitive-developmental paradigm for the teaching of reading, I recognise that this model of literacy education in England is delivered through a central government-controlled curriculum and assessment model that punishes any school that fails to enforce it to the letter. My aim in moving between the design studies (academic research) and exploration (an imaginative response to this knowledge) phases during this part of the project was to propose design interventions to ensure that every reader could succeed within that pedagogic model. Consequently, the nook design reflects this paradigm of reading education but also attempts to create, through design, a more reflective, nurturing environment for reading for the children who are currently moving through this stage of the educational system.

The design exploration element of this phase, prior to the realisation of the first version of the nook, was primarily achieved through the development of a design brief for the nook, a designed artefact being a requisite of the framework. During this first phase, I needed to find a method of communicating aspects of the academic research I had undertaken about reading and readers to the architects who were co-designing the nook. They suggested that I created a design brief for them: a medium with which they were familiar and which inhibited the possibility of an esoteric explanation of reading and readers in schools. They responded imaginatively to the brief with sketches and drawings. Using Fällman's framework also allowed us all to temporarily put aside the practicalities of the materiality, assembly and financing of a prototype nook. Eventually, the architects created a series of two-dimensional plans of the nook and a computer aided design programme (CAD) was used to create a virtual model of the design, marking the end of phase one.

Phase one concluded with the synthesis of the design studies and design exploration activities as shown in a preliminary plan of the nook designed with SCABAL architects. The nook design addressed findings from the academic research, including evidence gathered from several fields to suggest that young readers are directly and adversely affected by the poor design of school buildings, in particular, poor acoustic design. Several cohorts of children who are learning to read are particularly disadvantaged by noise in their school due to impaired hearing; autistic spectrum disorder (ASD); and those for whom English (in English-speaking schools) is not the first language. It also became apparent that acoustic standards vary within English schools, according to the types of space where readers learn. Designated teaching spaces, such as classrooms and small group rooms must be constructed to a higher acoustic standard than non-teaching spaces, like dining halls and gyms and if there are few small group rooms available, then beginner readers are far more likely to be learning in the reverberant acoustic of a hall or corridor.

Phase Two: Design Exploration and Design Practice

In the second phase of the project, with the idealized, imaginative concept of a reading nook in mind (the design exploration element), I began my empirical research in schools (design practice). This phase had two main objectives: firstly to ascertain exactly where within the school building beginner readers read and secondly to consider whether these spaces met the needs of readers and teaching staff. Having already completed an initial design for a nook, this phase allowed me to investigate whether this prototype would be suitable for schools and contribute to a better experience of reading for young readers.

Seven schools in London were chosen to reflect diverse eras of building (between 1887 and 2012) and socio-economic circumstances of pupils. In each school I observed teaching and spatial practices of reading in a Year One classroom; recorded conversations with children and teaching staff about reading and reading spaces; measured and photographed examples of reading spaces designed or commissioned by teaching staff. I was led on individual guided tours of the school by six children from one of each of the Year One classes. I also investigated whether children who were identified by their teachers are less proficient than their peers in Year One class were more likely to be withdrawn for extra tuition to a space beyond the classroom and where each of these children was taken for reading tuition.

To fulfil my first objective of locating the reading spaces where readers read, I documented every space that a child indicated to me on their tour as somewhere they had read. They guided me to reading spaces in classrooms and corridors; to screened-off corners of assembly halls; to bespoke, hand-crafted reading pods and to Perspex pods in full view of anyone who might pass by. Some beginner readers showed me to beautifully designed, secluded structures that afforded privacy and comfort while others pointed out dusty corners and plastic crates of books.

I also discovered that the qualities of designated reading spaces sometimes varied greatly between classes in a single school. Although the classroom footprint was generally broadly similar, the design skills and experience of the teaching staff and their ability to access resources (both material and financial) meant that reading spaces in different classes in the same school could be quite different in intention and execution. Many of the teachers I spoke with did not make a connection between the qualities of reading spaces and the child's experience of reading although each one of them expressed a deep enthusiasm for promoting reading and were passionate about children's literature.

The co-ordination of design for reading across the school outside the classrooms was haphazard in every school I visited. Library spaces, with poor acoustics but often beautifully designed furniture, were often used for the tuition of beginner readers. Classroom spaces, by contrast, usually had superior acoustics but were generally poorly provided with comfortable furniture or sufficient display and storage of books. Additionally, teachers were often unsure where their pupils had been taken for their supplementary reading tuition by teaching assistants and had little or no input into the design of these spaces.

A strong recommendation arising from this study is that schools should be encouraged to make an audit of reading spaces outside the classroom as the first step towards improving design to support all readers in the school building. A simple taxonomy, such as the one below, summarising the spaces where children read across the seven schools I researched, could be a starting point for such an audit (Fig. 4).

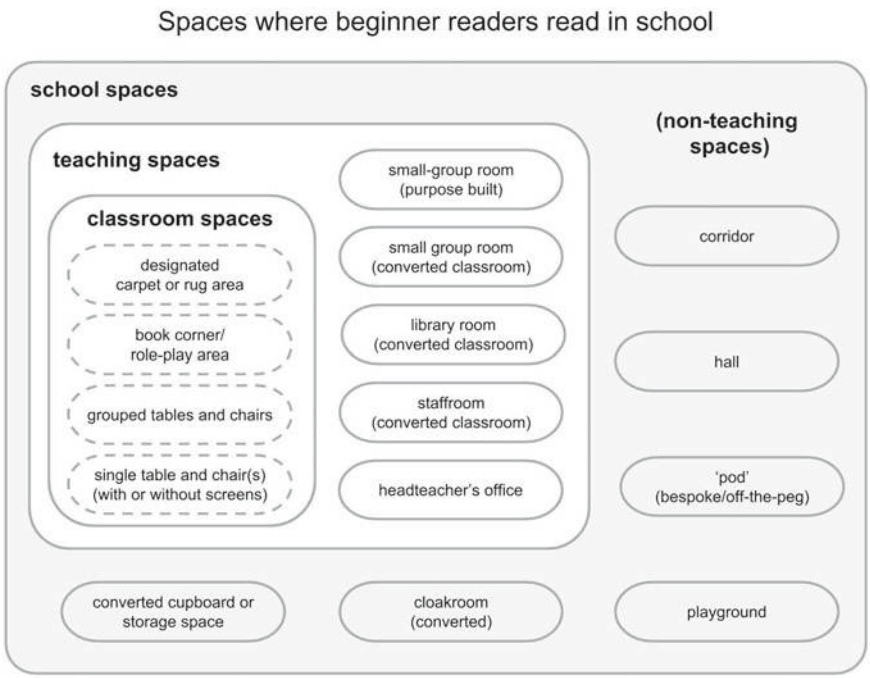

Fig. 4 Mapping the types of spaces where readers read in school

Phase Three: Design Practice and Design Exploration

In the third phase of the research, I returned to the nook artefact and to the second design phase while also attending to the practical considerations of budget, materials, time and dimensions of the nook so that it could be realised as a physical object to be used in further research in schools. Having created a virtual nook during the design exploration phase, I was able to assess the viability of the design in each of the seven schools visited during the course of the study. Following these visits, I made the decision that the final nook design should be viable in each of the seven schools to ensure equality of opportunity for all pupils, no matter which school they attended. Two of the classrooms visited were notably smaller than the other five and this led to significant design changes in its dimensions, including the removal of the bulky seat/bench and the introduction of a far smaller entrance to the nook. The latter meant that the nook would no longer double as a teaching space since access would not be possible for some adults. In my survey of Year One classrooms I had also observed that only three of the seven schools would have been able to accommodate the ventilation system designed by the architects for version one of the nook because it depended upon access to an outside wall. This, in turn, substantially limited the affordance of the nook as a soundproof space. To compensate for this adaptation, a greater focus on visual seclusion was introduced. Having witnessed children reading in a large, transparent pod, which reminded me of a goldfish bowl, this increased visual seclusion also eased my worry about the transparency of Perspex in the original design. No one wants to be watched when they are learning a new skill.

Having completed the second design, I was aware that the cost of financing a physical model of the nook to scale would be well beyond my means as a graduate researcher. A postural support manufacturer, Jenx, generously offered sponsorship at this point to complete the final design and modelling of a series of nooks made in their factory. They also ensured that all safety specifications were fully met so that the nook could be researched in schools (Fig. 5).

The second version of the nook now offered an alternative, protective space within the classroom where students could share books together or enjoy reading alone. During my empirical research in schools I had also found that storage and display for picture books were poorly provided for in classrooms. Ample provision for the display of books of all sizes that were easily accessible to students therefore became a priority during this redesign.

An Extension of the Project into a Fourth Phase of Study

> Children make a beeline for it. It's something children would never get bored with.
>
> We have powers in here!
>
> We're on a spacecraft. Everyone in their seats? I'm ready to blast off and see some stars!
>
> (Comments about the nook by staff and children)

Fig. 5 The reading nook

Following the completion of my doctoral research project, but continuing with the design exploration and practice elements of Fällman's framework, two nooks were funded, built and installed by Jenx in two inner-London schools. Neither school had taken part in the original study. I visited each school on six occasions to observe how children and staff responded to their nook. Each nook was set up in a corner of a Year One classroom but since they were fabricated from cardboard, the nooks were easy to move within the classroom and teachers were able to experiment with their positioning.

The application of Fällman's framework supported this fourth phase of research in its five aims:

– To observe where, when and how beginner readers read within the Year One classroom inside the nook.
– To observe how the reading nook space is inhabited and managed by children and teaching staff.

- To evaluate the designed qualities and affordances of the reading nook through observation and conversations with children and teaching staff.
- To record uses of the reading nook beyond reading.
- To consider the viability of further applications of the reading nook beyond reading.

The opportunity to construct a physical outcome to the research project led to the second set of research findings about the ways in which the nook was used in a real school setting. The nook offered a non-narrative, imaginative space in which children could read, reflect, rest or play. Although reading was encouraged in both of the two classrooms researched, it was not enforced. I observed that children's interactions inside the nook were often notably more playful than in other areas of the classroom. Children's use of language inside the nook, in which they were visually but not orally concealed from the rest of the class, was also playful: sometimes pre-verbal, poetic and sung rather than spoken.

The nook was used and enjoyed by the class in different ways in the two schools. The personality and teaching style of the class teacher were particularly influential in dictating how the nook was received and used. In School A, the teacher used the nook in a more limited way, mostly for guided reading sessions and some free play. The timetable in this school was rigorous and less exploratory than in School B, where the teacher used the nook in many different and imaginative ways: for reading, for imaginative play and to help the children to learn how to negotiate boundaries and spaces and to learn how to get on with each other in the classroom. She also made the arrival of the nook into an exciting event for the children and this resulted in an imaginative response through drawings and stories about the nook by the children. As a result, the nook in School B seemed to be a more integral part of the classroom and several children in the class were eager to use it as often as possible. It may be, as the teacher suggested, that some of the quieter children found the nook too overwhelming as a space when other children were playing inside and only ventured in when they could be alone or with one other child.

In one of the schools, the premises manager was extremely enthusiastic about the project and began to create his own version of the nook so that other classes could share in the experience. Additionally, children with special educational needs from other classes were sometimes brought to the Year One classroom where the nook was located, when the class was absent from their own room, to spend time there with a member of staff. On one of these occasions, it was reported to me that a child with elective mutism had begun to speak inside the nook for the first time.

The nook fulfilled a dual role in both classrooms, as a reading space with accessible display shelves for books on its exterior walls and as a role-play area. The dimness of the light inside the nook also provided a space where children could find solace and calm down when they were feeling overwhelmed or overstimulated.

Conclusion

The framework described in this chapter offered a creative, real-world and conceptual way of exploring how reading spaces are designed and used in schools and how they might be improved. The artefact that resulted from the research may now be used to research reading using a different methodology and framework. The primary aim of the doctoral research was not only to design an alternative reading space but also to re-evaluate and reimagine the way in which education in general and reading in particular can be viewed through the prism of design. This can ultimately encourage practices, routines and spaces to become more visible to the end-user and to designers, architects, building contractors and policy-makers and to promote change.

Beyond the contribution to knowledge about the types and qualities of spaces where students learn to read in primary schools—an aspect of educational research that has long been neglected—I hope to have demonstrated that Fällman's framework can be used and adapted as an innovative method of rethinking many aspects of school design. Using this framework, I argue, can challenge habituated spatial practices and arrangements in schools that are viewed by educators and by designers as commonplace or neutral.

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References

Blundell Jones, P. (2014). The development of the school building and the articulation of territory. In P. Woolner (Ed.), *School design together*. Abingdon: Routledge.

Edgerton, E., McKechnie, J., & McEwen, S. (2011). Students' perceptions of their school environments and the relationship with educational outcomes. *Educational Child Psychology, 28*(1), 33–45.

Fällman, D. (2008). The interaction design research triangle of design practice, design studies, and design exploration. *Design Issues, 24*(3), 4–18.

Mayall, B., Bendelow, G., Barker, S., Storey, P., & Veltman, M. (1996). *Children's health.* London: Falmer Press.

McLaughlin, T. (2015). *Reading and the body: The physical practice of reading.* New York: Palgrave McMillan.

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Inhabiting

Introduction to Part II: Inhabiting

Thomas Kvan and Kenn Fisher

Abstract This section presents research in inhabiting new learning environments. The topic is introduced, and a brief review is given for each chapter in the following section.

This section brings together papers that have a particular focus on the ways in which the users inhabit the spaces. By reflecting on their use of the space, their movements and the learning activities, insights are offered on the ways we can support better learning through physical interventions and through changes in mindsets.

Broens argues that physical diversity within a larger space is more beneficial for teacher collaboration than the flexibility of the furniture or the architecture. Drawing on her background in educational anthropology and many years of experience teaching young children, she focuses on the mobility of the inhabitants rather than the effectiveness of the material affordances in the ILE's. Broens observed a team of teachers for 300 hours, with associated interviews using an ethnographic approach, to understand their spatial behaviours.

The study found that teacher mindsets often saw them default to a traditional classroom approach, but that 'open' flexible innovative learning spaces offered greater agency for teachers to interact with each other, without built barriers impeding in this activity. She proposes that it is the social relations established within a space rather than the physical elements of the space that are essential, yet these cannot exist without the physical. Teaching only under the sky is not the option and, even then, the physical is contributing. She notes, however, that certain spaces enabled or promoted more active engagement in the experience of teaching and learning. This in turn supported better collaboration. She concludes that an intentional diversity of spaces is more effective in supporting collaboration than the provision of flexibility. The need, however, is for the users to adapt themselves to the opportunity. As she

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notes, ‘the use of space is a relational construct not only between the teachers, and the space, but also between the teachers and the students and between the students themselves’.

Morrison and Healy explore how research into learning environments might itself be conducted differently. Starting with a performative art experiment, they develop a perspective on the role of the researcher, the focus of their research and the methods by which they participate, in particular through presence. Their observation is that the researcher is a present actor in the research, a collaborator in the school environment in their gathering and interpretation of the data. In the context of inhabiting, this observation is critical, reflecting the participative process of inhabitation. Users of spaces do not take on the designer’s prescribed intent, they co-design and redesign the space as it is used.

Shapiro proposes a complementary perspective that introduces a method to describe and interpret the spatial interaction of people over time, an approach called *interaction geography*. By examining the engagement of space in a museum, mapping movement and conversation throughout a visit, and visualising this in a multi-modal mapped representation, a spatial representation of learning is developed. Specifically, he reviews the Mondrian Transcription approach which tracks movement and conversation in space and time and then deploys the Interaction Geography Slicer (IGS) to illustrate these patterns in a dynamic visualisation analysis. The resulting diagram of the dynamic engagement in space while in a learning activity offers us a broader perspective of the group activity that may enable us to reconsider spatial support of pedagogy. Shapiro concludes that this approach is highly interdisciplinary, and can be scaled, but it also needs some additional technical development to interpret the results that vary with scale.

If one of the goals of ILEs is to facilitate better participation in learning, the ease of communication is a key factor. A goal of ILEs is to ensure participation by students is broad and equal, so spatial arrangements do not prejudice or privilege anyone in the space. A common observation of ILEs is that there are fewer acoustical divisions and hence an activity in one area can readily impinge on other users and their activities.

Rose-Munro focusses on a particular aspect of spatial interaction in learning, the auditory. In particular, she brings our attention to the support of learning by all, including those with constraints with hearing abilities, by considering speaking and listening. She notes that 7–10% of students are likely to have ‘suboptimal hearing abilities’, and also points to the increase in students having autism spectrum disorders who will benefit from reduced auditory distractions. The connected visual spaces of ILEs bring with them interconnected auditory environments; while sight may be limited by interposing temporary barriers such as paper or screens, sound is not so easily contained. The transit of sound is less easily intuited and thus more difficult to anticipate and manage. Supporting active listening for students with hearing problems is more challenging than reducing visual distractions.

Rose-Munro found that students intuitively knew the ‘sweet acoustical spots’ in various learning spaces and inevitably settled in those spaces. But she also found that sound loop affordances for teachers also provided much greater clarity for students. She also found that student engagement was related to student agency and the formation of trust with teachers. With these findings, she helps us understand how to improve ILEs as inclusive spaces for such students, for example by developing acoustic nooks and by trusting peers to mitigate the difficulties through personal interaction.

Thomas Kvan (Australia) is recognised for his pioneering work in design, digital environments and design management and has held senior leadership roles in several universities as Dean and Pro Vice Chancellor. He was the founding co-Director of LEaRN (the Learning Environments Applied Research Network) delivering multidisciplinary research on learning and architecture, and was founding Director of AURIN (the Australian Urban Research Information Network) that developed a national digital infrastructure, both networks hosted at The University of Melbourne. He has published over 180 publications in academic, professional and popular channels. He is currently founding Dean of the School of Design at the South University of Science and Technology (SUSTech) in China.

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The Mobility of People, Not Furniture, Leads to Collaboration

Mie Guldbæk Brøns

Abstract This chapter considers how teacher mindsets, in connection with the physical possibilities at hand, lead to spatial habits and teaching practices. It draws on empirical material from an ethnographic study examining how teachers are influenced unknowingly by the roots of their profession and thus arrange furniture in ways that do not always support their pedagogical intentions. I argue that physical diversity within a larger space is more beneficial for teacher collaboration than the flexibility of the furniture or the architecture. I conclude by noting that we can gain a deeper understanding of innovative learning environments by looking at the positioning and mobility of the teachers' bodies in the space.

Introduction

In this chapter, I argue that physical diversity within a larger space is more beneficial for teacher collaboration than the flexibility of the furniture or the architecture. This chapter represents a small part of the research I did in connection to my master thesis in which I explored how Australian teachers who wish to collaborate used an open flexible learning space. My ethnographic study examined how teachers are influenced unknowingly by the roots of their profession and thus arrange furniture in ways that do not support their pedagogical intentions. My study was built on 300 hours of observation of a teaching team consisting of six teachers working with 180 Stage 3 (5th and 6th grade/year, 11–12 year-olds) students in one open plan learning space in Sydney. The space was designed as a collaborative and flexible environment for the teachers as well as the students with custom-made movable modular furniture, large-screen displays and a robust Wi-Fi network with access to online resources, all to ensure that both teachers and students are able to move around in the space with a high degree of choice. I chose this learning space because the school is well known for being successful in changing its physical environment to support its pedagogy (Calvo, 2015; Mayfield Awards, 2012). This space was the first the school changed

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to reflect their pedagogical intentions and it had been in use for four years when I undertook my fieldwork, aiming to explore the dynamics behind a teacher team used to working in an open flexible space.

The space was an important element of my investigation of teachers' collaboration because, as Foucault argues, it is somewhat arbitrary to disconnect the practice of social relations from the spatial distributions as it is impossible to understand one without the other (Crampton & Elden, 2007). Most of us will find it hard to imagine school without imaging a building or a space at the same time. The same goes for teachers' practices, which are closely connected to their understanding of education as a spatial practice and influenced by the long history of dividing students into classrooms. During my fieldwork, I discovered that when certain traditional teaching practices were taking place accompanied by the teachers' physical positions near display-screens, no teacher collaboration would occur. In contrast, less rigid behaviours were observed in spaces shared by other teachers; in these the teachers moved around more and engaged students in learning in a greater variety of ways. This spiked my interest into researching how the teachers position themselves in relation to each other, both physically in the space, and as members of a team.

In this chapter I consider how teacher mindsets in connection with the provided physical possibilities lead to spatial habits and teaching practices by reporting observed practices in shared teacher spaces with movable furniture. I conclude by noting that we can gain a deeper understanding of innovative learning environments by looking at the positioning and mobility of the teachers' bodies in the space.

My Perspective on the Field

This study is an ethnographic study, which is an approach increasingly being used within learning space research when looking at the physical space and its social actors (Blackmore, Bateman, Cloonan, et al., 2011; Campbell et al., 2013; King, 2016; Palludan, 2005; Saltmarsh, Chapman, Campbell, & Drew, 2015; Yeoman, 2015). Ethnographic studies are an asset to educational research, because as a researcher you have an opportunity to immerse yourself into this rather complex field and present an aspect of it. I am exploring this field with an understanding that this research does not stand alone but is part of a developing 'body of work' within learning space research that aims to provide nuanced perspectives on complex learning environments. While much of the literature on learning spaces focus on the quality of conditions or users' perceptions, I focus on the educational practices and how the space is used and to what effect (Blackmore, Bateman, Loughlin, et al., 2011).

My inquiry is inspired by social science research on cultural spatiality and texts, which try to understand how people interact with their environment, and see space as both a medium and a product of social practice (Augé, 1995; Berger & Luckmann, 1991; Foucault, 1975). I focus on the social practices of the teachers and on understanding how the space is produced and reproduced by their agency. For the purpose of this study, I understand everything as socially situated and my perspective is that knowledge and development occurs in the interaction between people and objects.

To have a broad perspective and keep an open mind to new ideas and impressions, I used a range of methods in my fieldwork that helped me expose various themes in the field. Drawing furnished floor plans and registering users' movements turned out to be one of the most valuable methods even though I had little previous experience drawing floor plans and it was very time consuming. By measuring the space and registering all the furniture for the floor plan, I got to know the place intimately and I became aware of all the furniture and spaces that were never used. Had I solely been focused on observing the users and following them, I would not have paid attention to what they did not use, which provided an insight into how the teachers interacted with the space in general.

I examined my data using thematic analysis (Braun & Clarke, 2006; McCarter & Woolner, 2011; Thomas & Harden, 2007), a research tool used to identify, analyse and report themes or patterns within data. Themes and patterns are found through phases of coding, where important instances in the data first are identified and then developed. Initially I coded all my field notes based on themes I had found in my drawings. Then I re-interrogated the data and found recurring words based on physical places and finally I went over the data using the themes that I had established from the patterns developed through my two initial codings. I would, for instance, cluster activities together that would take place in various spaces, thereby noticing that I could interpret the activities to represent two particular and very different types of behaviour, *passive* and *active*. I then chose to use these two categories to re-examine the data with a comparative analysis of the teachers' and students' behaviour to find out if different combinations of active and passive behaviour among the teachers would limit or enforce certain behaviour amongst the students in any way. The power relation between the social actors, especially the teacher's power over the students, might be less obvious in a flexible and/or open learning space than in a classroom setting. Thus it is important to find a tool that can help analyse how the power relations are in this social setting, both between the users and their surroundings.

Flexible Learning Spaces

Within education, flexible space is a terminology used to describe spaces that can easily be reconfigured by the users established with the intention of providing opportunities for the teachers to create places that suit various activities and group sizes. Flexible spaces often, but not necessarily, contain several identical pieces of furniture in order for multiple users to be able to set up the space the way they see fit for the situation by moving the furniture around. In larger flexible spaces folding walls are often installed so the users have the possibility to resize the space ad hoc. However, flexibility in the physical setting is not necessarily equal to the organisation being open-ended in the way they organise activities or people.

Skills or knowledge about architecture, design or spatial behaviour are not a requirement for teachers who occupy flexible spaces, and though teaching is a spatial practice, understanding the influence of spaces and physical elements is not typically a part of the education to become a teacher. The established set of attitudes that characterises teachers' daily use of space is thus formed by the history of the profession and the buildings it has taken place in, not professional spatial understanding, reflections and discussions. The teachers' mindsets are the prerequisite for their actions and their repeated actions become the habits which dictates the way they set up and use the flexible spaces.

Power Relations in the Learning Space

The teachers generally have the control over the space in which they teach because they set up the space(s) as they see fit before the year/term/lesson starts whether the furniture is mobile or not. The teachers are the creators of the space when they reconfigure the space ad hoc for certain activities, and because they configure the space in more permanent settings. Thus the teachers have the power over the students, in that they dictate their ability to use the space. The students, however, only co-create the space when they choose places and furniture to work at. After an activity or when the day ends, the space will be 'tidied up', a common discipline within educational culture, which means that the furniture will be returned to the places dictated by the teachers. Foucault (1975) argues that the use of power is often invisible to the social actors. Discipline, he states, is the mechanism of power that regulates the thoughts and behaviour of the social actors; people are being shaped without realising it.

As part of my analysis I chose to use concepts developed by Foucault who considers spatiality an integral part of the power relations between the social actors. His theories are built on the notion that power only exists when executed and is not something that can be possessed (Richter, 2011). When we (people) exercise power, there is usually a rationale or knowledge associated with it, we have a knowledge of what we do and what we intend. However, it is important that we do not confuse intention with effect because there is always an element of uncertainty associated with power as it involves more than one actor. This can lead to the outcome not necessarily living up to the intention (Richter, 2011). As in the example above, where the teachers in reality have the power through the configuration of the space, even though the school purposefully designed the space so both teachers and students would have a high degree of choice and agency.

Foucault argues that we can use panopticon, an hierarchical organisation, as a schema to inform us of where to distribute individuals in relation to each other in the space, whenever dealing with 'a multiplicity of individuals on whom a task or a particular form of behaviour must be imposed' (Foucault, 1975, p. 205). If that is the case, we must be able to reverse the schema and use it to investigate why the individuals are distributed the way they are, the hierarchy of the furniture and the disposition in space.

As part of my investigation of the hierarchy of the furniture and their placement, I analysed my furnished floor plans by first categorising the different elements such as furniture that one would: sit on, use as table tops, use for storage or use to support a presentation. Then I converted the floorplans into diagrams focusing on various power relations between the spaces, the furniture, etc. After having worked with different divisions, diagrams and categories, a pattern emerged. Not only were spaces within the larger open space created, in large, by the furniture, but the presentation furniture would address the rest of the space and the seating furniture would address the presentation furniture. This organisation was creating spaces, within the larger open space, that was closed in on themselves and not interacting with each other. The dominating element defining every one of these spaces is what I call the front. The front would most often consist of a display-screen or a whiteboard (whether mobile or painted on the wall) and was to a large degree defining the teacher's place within the space.

Fixed Teacher Positions

When using a display-screen, the direction of the viewers is automatically established. The teachers use the display-screens as a visual aid for their explanations and stories while standing next to them, using them like one would use a stage, thereby taking advantage of the furniture's hierarchy to naturally attract attention from the students—their audience. When, during the design phase, a front, which is used for direct teaching, is established, they reinforce this activity and the role that the teacher has while engaged in the activity. When the teachers take their place at the front, certain expectations concerning behaviour are 'projected' into the space. No-one is in doubt that whomever is at the front is the one we should all be listening to. 'Eyes up front' is a term we know from classrooms when teachers want the attention of their students. In this situation the hierarchy of the space and the actors is clear. The listeners are expected to be docile and the teachers have the perfect position for supervising them while they teach.

Surveillance is, according to Foucault, an inherent mechanism in the practice of teaching (Foucault, 1975) and though we nowadays do not talk about surveilling the students, we do still emphasise the importance of 'supervising', 'keeping an eye on' or having an overview of the students. This educational culture is apparent in the design of the space I observed, where all the display-screens have been placed where you would stand to have the best overview of the building. Four out of six teachers had placed their caddies (mobile teacher table) permanently at the front in close proximity to the screen. It is likely that the action of placing mobile furniture permanently is not questioned because it is a spatial distribution we are used throughout the history of education. During explicit teaching sessions where the screen is used as an aid, it makes sense because the teachers rest their laptop on the caddy. However, the teachers never move their caddies and therefore themselves after their presentations, even though the students leave their positions to spread out and work independently.

The teachers' bodies become passive and docile in this position, disciplined by the space (the front) and furniture (screen and caddy). Slowly, the space around them is adjusted to this position's permanence, and they start creating an independent space suited for all the different activities and groupings they are working with. The spaces are arranged around the teachers providing options within eyesight and at the same time limiting the options that would require movement. The furniture are moved and arranged within the space near every fixed teacher position instead of grouped throughout the overall space. When the students work independently in groups or individually, they find a place where they would like to sit and work which is mostly based on a choice of which furniture or floor-space they feel comfortable working at or on. Unless mixed in groups or pairs consisting of students from both year groups, students choose to work close to their home base and the teacher. The teacher is either roaming in the nearby space or working at their fixed position next to their caddy. In this way the students and the teachers reinforce each other's positions close to or in the home bases. Gradually, the configuration of the space is influenced more by the teachers' docile bodies than by their pedagogical beliefs.

The teachers' fixed positions in the space separated from each other cause division in the space as well as in the teaching practices. By using the screens to structure the learning sessions the teachers revert to a more traditional furniture setting and practice and their positions become a catalyst for how the students can and will use the space(s). In duplicating the features between home bases the diversity of the spatial configurations in the overall space is diminished. The intention of the flexible space and furniture was not to create multiple almost identical home bases, but to provide opportunities for the teachers to create places that would suit the various activities and group sizes.

Teacher-Mobility Leads to Collaboration

The fact that the home bases are composed of the same elements, makes it less significant for both students and teachers to choose between them, with consequences for their collaboration. Already during my fieldwork, I identified that the teachers working in one half of the space were collaborating more, however, it was not until my analysis of the elements in the space and the teachers' movements that I realised the correlation between the established fronts and teacher collaboration or lack thereof. In the area where three home bases are sharing only two well-functioning display-screens, the teachers tend to collaborate on introductions and explicit teaching sessions. There is not a fixed position next to the display-screen as the teachers place their caddies elsewhere and use a generic table to support their laptop when using the screen. The table is also used by teachers as well as students when working independently. This organisation of furniture and hierarchy in the space leads to the teachers working closer together and roaming around the space when the students work independently.

Through my analysis of the teachers' movements around the space with only two display-screens I uncovered that the teachers' mobility and engagement in shared activities support collaboration in the team. Teachers who move around in a space together and amongst each other are more likely to collaborate because they have to negotiate, coordinate and share. They start using more time on planning the use of space and how to utilise each other when executing learning activities. Not having enough screens for all teachers to use, thus having to share, prompted them to collaborate even when it was not their first instinct. Repeated behaviour is what becomes habits and the easiest way to discontinue a unwanted habit is to replace it with new repeated behaviour. If the new habit is to reflect with colleagues about which practice to use, it is more likely that new habitual practices will not take hold. This encouragement of reflecting upon fixed practices supports the growth mindset which is valued in educational environments and learning organisations. Reflecting together, the teachers join in committing to the task of optimising the learning situation. When a team has a joint commitment, the commitment no longer belongs to the individual but is shared amongst the collaborators (Amit, 2012). Sharing the commitments and responsibility helps alleviate stress for the individual and frees up energy within the team. Unfortunately, this type of deep collaboration (developing and executing student activities) is rare to see in typical educational environments (OECD, 2016; Schleicher, 2016).

My analysis of the situations in which I observed teachers' collaboration identifies that the most valuable spaces for teacher collaboration are those spaces that are not allocated to any specific group of users but where the users cohabit it and use it depending on which activities are being organised. It is possible for multiple users to share a feeling of association and belonging to a space as long as no individual has priority or a permanent place in that space. The hierarchical organisation of the space and actors enables teachers to have equal rights over the space, help all the students working there and to find ways to move around amongst each other and work together.

Dixon (2013) suggests that we should look at and listen to children's bodies before we teach, because they are the target of pedagogical power, this is a way to understand the impact and consequences of the powerful discourses they are shaped by. Inspired by Dixon, I suggest that when designing or researching learning spaces in the future, we will benefit from looking closer at the positioning and mobility of the teachers bodies in the space.

Summary

I was interested in investigating flexible open learning spaces because current practices encourage spaces that can be reconfigured as a way to provide teachers with choices for their preferred learning setting. An important point of my analysis is that flexible spaces are not equal to the organisation being more open-ended. Teachers' mindset is challenged when transitioning into a flexible space from a traditional setting, however, it is rare for schools to prioritise the professional development of the teachers' spatial mindsets amidst all the other daily responsibilities. Supporting a growth mindset through the configuration of the physical space can help teachers question their habitual behaviour and the mindset behind it. I observed that both the teachers working in more fixed positions and the teachers working more mobile collaboratively had growth mindsets, the main difference was if this was supported by the physical environment they were teaching in. Seeing them from time to time swap spaces confirmed this as they would almost instantly adapt to the more fixed or collaborative mode of working. Encouraging negotiations between the teachers proved beneficial to their collaboration which in turn supported the individual teacher to establish new routines and practices.

I argue that an established diversity within a space is more beneficial for teacher collaboration than flexibility because the teachers share the space when they moved around in it, not when they are moving it around. During my analysis it became clear that no matter how much the teachers tried, their pedagogical intentions were in effect changed by the strong influence the physical setup had on user's behaviour. Physical elements strongly influence the choices the teachers make about where to place themselves in the space. Teachers could feel that they were sharing a larger space meanwhile creating their own spaces within it, where their positions and practices would resemble those of traditional educational environments based on closed classroom. The difference being that in the open space, the individual teacher's practices and behaviour influence the behaviour of the other actors in the space. The use of space is a relational construct not only between the teachers, and the space, but also between the teachers and the students and between the students themselves. An examination of this could provide further important insights into the use of open learning spaces.

An important point in my larger analysis of teacher collaboration (of which this chapter reflects one segment) is that learning how to share a space is an individual journey that involves changing practices and habits. However, the journey takes place in a joint process with all the teachers who share the space because moving around in the spaces in order to cater for different activities entail that there are no fixed teacher positions. Transport between spaces, which can be done without coordination, does not attribute any value to the learning situation or teacher collaboration. Whether moving around within a space or between spaces thus becomes an important distinction.

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References

Amit, V. (2012). Community as "good to think with": the productiveness of strategic ambiguities. In Amit, V. & Rapport, N. (Eds.) *Community, Cosmopolitanism and the Problem of Commonality*. London: Pluto Press.

Augé, M. (1995). *Non-places: Introduction to an anthropology of supermodernity*. London: Verso.

Berger, P. L., & Luckmann, T. (1991). *The social construction of reality*. Bungay: Clays Ltd. St Ives plc.

Blackmore, J., Bateman, D., Cloonan, A., Dixon, M., Loughlin, J., O'Mara, J., & Senior, K. (2011) *Innovative learning environments research study*. Deakin University.

Blackmore, J., Bateman, D., Loughlin, J., O'Mara, J., & Aranda, G. (2011) *Research into the connection between built learning spaces and student outcomes*. Education Policy and Research Division, Department of Education and Early Childhood Development. Melbourne.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Calvo, A. H. (2015). *A journey to the 21st century education. This is how the world's most innovative schools work*. Madrid: Fundación telefónica.

Campbell, M., Saltmarsh, S., Chapman, A., & Drew, C. (2013). Issues of teacher professional learning within 'non-traditional' classroom environments. *Improving Schools, 16*(3), 209–222. https://doi.org/10.1177/1365480213501057.

Crampton, J., & Elden, S. (2007) Introduction. *Space, knowledge and power: Foucault and geography*. Birkenhead: Ashton Publishing Limited.

Dixon, K. (2013). A change of perspective: Seeing through children at the front of the classroom, to seeing children from the back of the classroom. *Studies in Philosophy and Education, 32*, 273–284. Berlin: Springer. https://doi.org/10.1007/s11217-012-9347-y.

Foucault, M. (1975). *Discipline and punish.* The Birth of Prison. New York: Random House.

King, H. (2016). Learning spaces and collaborative work: Barriers or supports? *Higher Education Research & Development, 35*(1), 158–171. https://doi.org/10.1080/07294360.2015.1131251.

Mayfield Awards. (2012). Retrieved from mayfield.cefpi.org.au/awards/2012-awards/2012-category-2-renovation-/-modernisation/the-zone,-northern-beaches-christian-school.

McCarter, S., & Woolner, P. (2011). How listening to student voice can enable teachers to reflect on and adjust their use of physical space. *Educational and Child Psychology, 28*(1), 20–31.

OECD. (2016). *Supporting teacher professionalism: Insights from TALIS 2013*, TALIS. Paris: OECD Publishing. http://doi.org/10.1787/9789264248601-en.

Palludan, C. (2005) *Børnehaven gør en forskel*. Danmarks Pædagogiske Universitetsforlag.

Richter, J. (2011). Magt og afmagt i individets liv. *Psyke & Logos, 32*(2), 418–431.

Saltmarsh, S., Chapman, A., Campbell, M., & Drew, C. (2015). Putting "structure within the space": Spatially un/responsive pedagogic practices in open-plan learning environments. *Educational Review, 67*(3), 315–327. https://doi.org/10.1080/00131911.2014.924482.

Schleicher, A. (2016). *Learning environments as a third teacher*. Retrieved from http://pubdocs.worldbank.org/en/997521458819730105/7-Linkages-of-the-innovative-learning-A-Schleicher-eng.pdf.

Thomas, J., & Harden, A. (2007). Methods for the thematic synthesis of qualitative research in systematic reviews. *NCRM Working Paper*. ESRC National Centre for Research Methods. (Unpublished). Retrieved from http://eprints.ncrm.ac.uk/468/.

Yeoman, P. (2015). *habits & HABITATS—An ethnography of learning entanglement*. Ph.D. Doctorate, University of Sydney, Faculty of Education and Social Work.

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The Gadfly: A Collaborative Approach to Doing Data Differently

Sarah Healy and Caroline Morrison

Abstract The Gadfly first materialised as a provocative data performance at the Transitions Research Symposium held at The University of Melbourne in June 2017. The figuration of gadfly in the title shapes the figure of the researcher as (bothersome) questioner that provokes critical dialogue about the assumptions underpinning our own research practices and learning environments research more generally. This figuration provides us an entry point into working data through approaches offered by new materialist and post-qualitative research methods. The resulting data performance came together as a collaborative experiment inhabiting the in-between spaces of researchers, participants, research contexts, and 'data' initially generated in a Taekwondo training assemblage. Our collaborative approach involved an intra-active process as a way of *doing* data differently. Informing our process are concepts of intra-action, assemblage, affect, and sticky data.

Introduction

This chapter shows learning environments research being done differently. It explores the educational world through different conceptual lenses to those ordinarily used, and shows how alternative figurations of research and the researcher emerge. Where the figuration of the researcher in much educational research is of the 'objective analyst', the figuration at work in this chapter is of the gadfly as provocative questioner.

Enter the Gadfly

Socrates referred to himself as a *gadfly*—a horsefly with a nasty bite that, while irritating, did not do serious harm. Gadfly has a history. It connects thought across space-times; from provocatively questioning the wisdom of the citizens of Athens of

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the past (Plato, 1984), into the present, in our questioning and probing research data as we think-write differently in an experimental collaborative approach. The Spinozist and Deleuzean understanding that is forwarded in our experimental collaborative approach is of gadfly as a milieu of thought; other milieu being nomad, hermit, shadow, and border (Deleuze, 1988).

We draw on the figuration of the gadfly to question—and be questioned by—data. The purpose is to open methodological thinking-doing in learning environments research. We press this point because we believe that without methodological diversity, learning environments research risks reproducing 'self-limiting knowledge' (Elmore, 2018) of what they are, and how teachers as individual human subjects make them work (or resist their pedagogic potential). The problem as we 'see' it, is that research beginning with pre-existing assumptions of what and who objects and subjects are can lead to an oversimplification of the complex 'materialising processes of learning' (Mulcahy, 2018, p. 14). It can also lead to privileging the social while neglecting the contingent agencies of a range of participants in learning processes; for example: technologies, material objects, learning bodies, teaching bodies, and the consequential affectivities that flow in and between them.

To expand our view of what learning environments research could achieve, we turn to case studies of Science, Technology and Society (STS) which show empirically that society and nature (subjects and objects) are not separate from one another (Callon, 1986; Callon, Law, & Rip, 1986; Latour & Woolgar, 1986). Rather, these studies, alongside-related works, show how society and nature, and knowledge of reality, are effects of heterogeneous assemblages—that is they are co-constituted in entangled sociomaterial practices (Barad, 2003, 2007; Latour, 2005; Law, 2004; Law & Mol, 2002; Mol, 2002).

Therefore, the broad aim of this chapter is to explore the co-constitutive nature of sociomaterial practices that produce the researcher, the researched, and the research methods. We bring a performative sensibility to data practices, co-opting non-representational approaches developed by new materialist (Coole & Frost, 2010; Fox & Alldred, 2017) and post-qualitative research (Lather & St. Pierre, 2013). A performative approach emphasises how things, spaces, bodies, and knowledges, '… come to matter through the world's iterative intra-activity, its performativity' (Interview with Karen Barad, in Dolphijn & van der Tuin, 2012, p. 69).

Methodological Backstory

What follows begins with a brief methodological backstory to the gadfly-performance and an introduction to the analytic concepts of assemblage, 'sticky data', and affect. We then present our data work via a performative script, before finishing with a discussion of the possibilities emerging from doing data differently.

Drawing on Honan's (2014) paper, entitled *Disrupting the habit of interviewing,* as a model for how we might work empirical material differently, we engaged in a data-performance entailing a method of 'data talking, us talking data, and data talking back'. The concept of intra-action[1] (Barad, 2007) became central to our approach. Not only does it convey the co-constitutive nature of data, researcher, and researched, it is enacted in practices. Hence, this chapter maps our collaborative data intra-actions with three mini data-vignettes (Masny, 2014) configured from a Taekwondo training session involving a group of high-performance athletes and their coach in the lead-up to a high-stakes competition. The data-vignettes enfold material from various sources (field notes, sound bites, interviews, and photographs) including our researcher conversations. Our collaborative approach of doing data differently resists temptations to close data in on themselves, thereby disrupting what Honan (2014) identifies as habitual approaches to working with data. In the process, data actively join the collaboration, bringing into play new concepts, affects, encounters, and relations inside-and-outside of the research sites.

Thinking with Deleuze: Assemblage, Affect, and Stickiness

Our data workings also draw on Deleuze and Guattari's (2013) closely linked concepts of assemblage and affect. An assemblage consists 'of multiple, heterogeneous parts linked together to form a whole' (Müller, 2015, p. 28). The research assemblage enfolds researcher, research tools, research site, participants, and the Transitions Research Symposium audience. Rather than existing as individual human subjects, research 'subjects' (such as coach and researcher) assemble 'in' the data performance, existing in relation with the broader research assemblage. For example, during the performance, the researcher body merges with living and inert others as researcher-pencil-notebook-laptop-chair-desk-assemblage, before de-assembling and re-assembling in a different configuration of researcher-notebook-pencil-audiorecorder-sweat-smell-assemblage, only to de-assemble and re-assemble again, and again … (Somerville, 2016). Agencies are therefore distributed across the assemblage and are not defined by human action. In the research assemblage thus conceived, data are lively, consisting of living and non-living agentic elements, all exerting force (Bennett, 2010).

Collaborative process

We met in the staff dining area of the faculty a few times to work up some empirical data from Sarah's Ph.D. research for our eight-minute presentation at the Transitions Research Symposium conference. From the start of our collaborative work, we wanted to do more than 'just give a talk to some slides'—we wanted to perform so that data might remain vital (Bennett, 2010). Before our first meeting, we had each engaged with a selection of the empirical material on our own, taking up Honan's (2014) challenge to work data differently. We asked

[1] We work with Barad's (2003, 2007) concept of intra-action to convey the co-constitutive nature of data, researcher, and researched rather than interaction, which assumes that there are separate entities that interact.

questions of data, and of each other, and allowed data's continual challenge back to us to find what else was at work in assembling the learning environment of the Taekwondo training session. When we met, we talked, laughed, challenged, questioned, wrote notes, explained our thinking to each other and allowed some questions to stay, not answered, not 'explained'. Through this process the script that follows materialised.

Affect, as a transmission of intensity (Deleuze & Guattari, 2013), is one such force that we consciously attune to in this collaboration. Affect is integral to the assemblage because it acts as a pulse, becoming the source of its power, 'making the socio-material hold together or fall apart' (Müller, 2015, p. 36). Foregrounding the affective workings of the research assemblage moves us to seek out those moments of disconcertion in the data (MacLure, 2013) prompting our responsiveness to data that get 'under the skin' (MacLure, 2011, p. 999) and 'stick' to us. The 'stickiness' of data is an affective relation that functions variously to hold-together, block, or bind entities by accumulating affective value (Ahmed, 2014). The notion of 'sticky learning' has recently been deployed in educational research for its capacity to generate 'a different way of attending to the production and transfer of learning' (Mulcahy, 2016, p. 208). In our case, the notion of 'sticky data' becomes salient because it takes us deeply into the complex and 'dynamic process of discursive practices *and* the materiality of the body' (Zembylas, 2007, p. 29, emphasis in the original) that unfold in the Taekwondo training session.

Data Performances

This section of the chapter re-presents the script that we, author-researchers, performed at the Transitions Research Symposium in June 2017. It is comprised of three intra-active data vignettes. Centreing our collaborative process on intra-action, we enact an ethics that is response-able for and accountable to '… the lively relationalities of becoming, of which we are a part' (Dolphijn & van der Tuin, 2012, p. 70). We are interested in how enacting a very different methodology might become a point of entry for thinking-doing-caring learning environments research. So, throughout the data workings (the collaborative process) we instantiated the notion that 'Matters of fact, matters of concern, and matters of care are shot through with one another' (ibid., p. 69).

Data Intra-action 1: What Is It About the Smell?

[Sarah sits on stool holding journal—becoming researcher at Taekwondo. Carol moves to the researcher table and dons her researcher hat (literally a hat). A soundbite of athletes vocalising while they spar plays. Photo of training room on screen.]

Sarah: Taekwondo training session

- 7.30 am
- 17 high-performance athletes, 12–28 years
- 1 coach
- 1 researcher

I sit in a rectangular shaped room with mirrors down each side. The floor has red and blue taekwondo mats. Training mitts, kicking bags, and protective gear hang in orderly rows. There are ceiling fans—not on. And air-conditioning units—also not on. There is a particular smell.

[Sarah joins Carol sitting at the researcher table—hat on, notebook and pen in hand.]

Carol: Air con and fans not on? What is it about the smell? Assaulting the senses?

How does the smell affect researcher, athletes, and coach? The air-conditioning and fans are not on—the 'not on' fans attract—how? Smell and (not on) fans become part of this training assemblage along with trainees, coach, equipment and competition. How is our researcher attention called to what is (not) there?

Sarah: We can understand data that attract attention and stay with the researcher as 'sticky data'. The data vignettes are composed of data that stick (and stink). Data stick to the researcher and the researcher sticks to data. Not only do data have the capacity to stick but they can also have sticking points. The smell, the air con not on, fans—not on, unwashed training gear releasing microscopic particles into the atmosphere can clot.

Carol: Our researcher expectations enter the assemblage. Something expected to be there that is not there, to be 'on' or working but not working, reveals a contingent reality—an expectation of the future but one that will vacillate—a future that is both fans on and fans off. This working of data that become part of assemblages brings to attention the constant contingency at work between human and nonhuman agencies which, according to Spinoza, involves the passions and patterning of fear and hope.

Data Intra-action 2: Coach, Stopwatch, Whistle, and Stick

[Sarah changes: puts on tracksuit top, becoming coach. Carol becomes researcher sitting on the stool taking notes. A soundbite of coach-voice plays. Photo shows athletes entangled in a sparring exchange.]

Carol: The coach walks into the training room and the chatter that is athletes' chatter that accompanies the warm-up stops dead. Today the athletes are instructed to listen, NOT question. The first drill is explained; they break off into sparring pairs and begin. The coach has a stopwatch, whistle and stick. Every minute she shouts "CHANGE!" and the sparring pairs swap roles. The intensity in the four walls of the training room is palpable.

Sarah-Coach: (instructing in a loud voice)

– As I call out your name, you'll be on the defensive
– Keep going. No stopping. No talking!
– Frustrate your partner. Close your gaps. Frustrate, frustrate, frustrate!
– Change! The other line is frustrating now.
– Work the other person's patience. Look for the gaps in the attack.
– Change!

Carol: One sparring pair at the end of the room stop what they are doing. They've lost focus.

[Sarah changes: removes tracksuit top. Carol and Sarah move to research table and chairs—hats, notebooks, pens.]

Sarah: The clotting of coach-stopwatch-stick-whistle-shouting-pacing in a traditional martial arts training space 'appears' coach-centred. However, this rendering of the coach as coach-centred is incomplete; it reflects the notion of coach (teacher) as individual, intentional human subject. It misses the highly responsive bodywork that the coach is doing.

Carol: It brings to mind the work that teachers do in classrooms. What we as researchers see and hear is not all that is happening. We can also turn our attention to athlete (or student) bodies and their material-discursive practices. Moving with coach/resisting coach—becoming Taekwondo athletes differently? Identities are enacted through multiple connections with other bodies, other assemblages.

Data Intra-action 3: And so Often They're Buggering it Up

[Sarah becomes coach in tracksuit top—standing, leaning against researcher chair, she speaks about her practice. No soundbite. Photo of sweaty athlete bodies engaged in a group hug.]

Sarah-coach: "You can't overthink it because it becomes a little forced…

Sometimes I'll tap into the kids and I'll see that once they start fraying, that means they've lost control. So, I pull back a little. I stop counting the activities, I stop whistle blowing, I just keep it free. I'm conscious of not just yelling at them because then they'll become incredibly dependant on that. We don't want that. A class is designed around giving them a sense of empowerment over decision making. The decision is ultimately theirs, I just give them lots of options. Then we practice, then I put them under pressure. Then I'll pull back and see how they're going making that decision. And so often they're buggering it up. And then there's "BaaaH!" And that's fine. I'll come back in and reassert, reposition everybody. Changing partners is a big one because if they stay with the same partner they don't reboot."

[Sarah and Carol move to chairs. Hats, notebooks and pens.]

Carol: Fear and hope are intense in this vignette.

Does the coach work to allay fear and build hope through her body? Giving a sense of empowerment—is that hope that athletes can make the right decisions on their own? She builds muscle memory—body workings, working bodies helping them to not overthink? She pulls back to give them a go but they keep 'buggering it up'. Is that her fear?

Sarah: She puts the pressure back on, practicing again.

She is 'tapping' into the athletes, palpating their body-talk, responding in kind by modifying her own practice, modifying the intensity of the affective flows within the training assemblage, sometimes modifying the assemblage altogether.

Sarah: And then there is the assembling of sweat-bodies.

Athlete-partner-frustrating-sweating-in control/buggering it up! Athlete and coach bodies produce sweat, smell, and feelings that fold into other assemblages. It is not clear where bodies begin and end. The smell of Taekwondo hugs you. It is a seeping of sweat between athlete bodies into protective gear, permeating the atmosphere and thickening the air. It inhabits the data but you can't see or smell it in **this** data performance.

Carol: Thank god!

Sarah: It is both flashback and premonition that palpates stink-bodies in ever shifting patterns of fear and hope.

[Sarah and Carol move to lectern and conclude the performance. No hats.]

Discussion

Our discussion focuses on the bodily practices of the coach. The coach in the vignettes above is not assumed to be pre-existing human subject. Rather coach emerges through processual gatherings of sweat, movements, and practices of *coaching*. Coach is a code word with a history. All that can be known of 'coach' prior to the research are generalities, the way things are expected to be, the standards and histories of what has gone before. Codes take the place of action and work to silence affects and delete practices—codes have a politics. As Law and Mol (1998) propose, codes involve betrayal because they tell only of limited aspects and leave out so much. What codes cannot write easily are smells, sweat, oscillations of fear-and-hope, and the highly attuned bodywork that co-constitute coach (or 'teacher' if this argument is extended to teaching practices in school learning environments). In our research approach, coach*ing* is performed in processes of continually becoming-in-practices involving a myriad of intra-connected heterogeneous elements. Coach, and/or teacher, emerges as an intra-connected relational assemblage performed in multiple practices.

As we have described throughout this chapter, our methodology differs from conventional research which tends to position the researcher outside of the data (Cohen, Manion, & Morrison, 2007). This positioning of the researcher deploys pre-established frameworks with the purpose of distilling *complex* data into generalised 'facts'. Our issue with conventional learning environments research is that the focus is placed on human (mis)use of spatial affordances as though humans, spaces, and materials pre-exist learning and teaching practices. In this way the research quickly stabilises objects and subjects (in codewords) that are contestable and unstable, never quite fixed and certain. Yet, while seeking to reveal best-practice of how coach-teacher and athlete-learner inhabits and uses spaces is a worthy aim for creating greater certainty for educators and policy-makers to make decisions (Ellis & Goodyear, 2018), the danger is that materials and texts will continue to be characterised as separate from, rather than co-constitutive of, teaching and learning (Mahat, Grocott, & Imms, 2017). Research needs to find ways to story the intensity of relationships between learning spaces, teaching-learning activities, and heterogeneous bodies that do not fit pre-existing frameworks; find ways to allow data to speak rather than leaving it on the cutting room floor.

Research that reduces teaching and learning to simplified meanings is particularly troubling to us, especially given our thinking-doing-caring sense of the co-constitutive entanglement of matter. Where research methods reduce teachers' work to what can be made visible to the eye and measurable, some aspects of the coach's or the teacher's pedagogic practices[2] become threatened. The visible and measurable become new norms established within lists of standards which simultaneously work to reduce the complexity of teaching and learning practices. A possible outcome is the decrease of teacher's capacity to respond to the affective demands of the moment, such as coach describes her practices of: '*… tap[ing] into the kids … once they start fraying, that means they've lost control. So, I pull back a little. I stop counting the activities, I stop whistle blowing, I just keep it free*'.

Coach works the athletes who move in response to her voice—coach-voice-athlete-body-moves, co-constituting the Taekwondo training space. The directions she gives have a spatio-temporal history, folding space-time connecting Korean culture and (post) colonial history with a club in Melbourne, Australia, looking towards a future at the international competitions—a future tinged with hope and fear—folding athletes' well-rehearsed bodies, knowledge of the moves, of how to attack and defend, with coach body keeping them moving, pressuring, until she senses their loss of focus, '*once they start fraying*'. Her work is intense, from moment to moment, sensing the affective moves of athlete bodies, responding to changes, noticing their reduced concentration, '*so I pull back a little*'.

[2]Our understanding of pedagogy is of pedagogy as a relational process that is inseparable from learning. In our understanding, drawing on assemblage, pedagogy is enacted in relation to the world (Pickering & Guzik, 2008). As such, becoming a trained body, as in the Taekwondo training session, or becoming a competent reader in a focused reading lesson, is performed in affective relations with intra-active multiple material-discursive entities.

Compare the affective-intensities of the coach-athletes to the ways in which the classroom teacher is inscribed by contemporary learner-centred, twenty-first-century skills-based discourses. These contemporary discourses focus on what is visible, inscribing the teacher's mind (leaving out the body) as a facilitator who seeks and measures the learning of the learner, and uses that data to reflect on her own teaching. Teacher, in this scenario where only the learning that can be made visible and measurable is valued, is in danger of being reduced to the teacher reflected in the eyes of the responsibilised learner. In this view, teacher becomes non-teacher (Rømer, 2018, p. 7).

Nevertheless, we are not saying that contemporary teachers are victims of some malevolent re-assemblage of educational ideas forcing them to change, to be passive facilitators focused on learners in innovative learning environments, for there is no guarantee that 'innovative learning environments assemblages' exist in practices, or, if they will endure (Callon, 1986; Latour, 2005; Law, 1994). For, as we have shown in the body of the coach, and encountered in our own teaching, pedagogy is affective and lively, intra-connected across space-times with a multitude of other, different, assemblages which at the very least leave open an array of possibilities for teaching and learning. What we have tried to evoke in our performance is what some researchers of everyday assemblages in the life of schools (see for example: Mulcahy, 2012; Mulcahy & Morrison, 2017; Watkins, 2011, 2017) have illuminated well; that the affective capacities of bodies are indeterminate and ceaselessly inventive (Zembylas, 2017).

Conclusion

Our methodological data-working has helped us to attune our thinking-doing-caring to the minutiae of everyday practices, their affects and their material effects. Practices are 'Janus-faced' (Latour, 1987), facing in two directions at once with many consequences that cannot be known beforehand. For us as teachers, this is the joy and threat of the lively, embodied world—making what *is* always possibly otherwise. We want to argue that the teacher or coach or researcher self as a subject remains a 'site of possibilities' (Watkins, 2010), engaged in a process of mutual 'becoming with' the lived world.

Gadfly, as worked through this performance, provoked different ways of thinking-doing-caring data, by attuning us to bodily affects (including our own). We share the belief that an *uncritical* use of analytic strategies like coding and classifying data do not represent a reality out there, rather all research helps create the phenomena under investigation. As Law proposes, conventional thematic or statistical analytical methods are not wrong, 'rather, they and the relations in which they are located … both enable and constrain' (Law, 2004, p. 39) the conditions of possibility. That being so, a responsive and relational collaborative methodology that seeks to stay with the messiness and uncertainty of affects, of smells and sounds and pressuring and losing focus, can bring into view the everyday practices making, unmaking, and remaking learning environments. The point we make is that we researchers need to become aware of the realities we enact in our research practices, and the political work that these enactments of reality do. Methods that reduce complexity are political, 'since any attempt to reduce the number of available options for action for the 'elements' within a system is about the exertion of power' (Biesta, 2010, p. 498). Therefore, it is imperative that we attend to the politics of our research practices and their ontological as well as their epistemological implications.

Diverse research practices help us to think differently, and become researchers differently, by interrogating and disrupting what is emerging, assembling, and clotting. An integral part of this is our *process of collaborating*, an iterative process that involved data taking on the figuration of the gadfly too—showing that we as researchers also do not know what we think we know. This process became a powerful research tool that enabled us to enact an intra-active researcher subjectivity; of collaborations as sites of emergence that continually '… creates and recreates itself and its co-labourers as part of the currents and waves of the seas' (Neimanis, 2012, p. 217).

A further implication of this chapter's experimental practice is its potential to open a space for critical dialogue among the learning environments research community. Critical dialogue is needed to question commonly held assumptions that there are naturally occurring divisions between the researcher and researched, what our participants tell us and what we ask them, what and how we think and write in research texts, and participants' and researcher bodies (and minds). The performance-chapter is provocative in its attempt to unsettle pre-existing assumptions that reality can simply be represented in our research reports, distilled into fact sheets, or pinned down as a set of best practices. Moreover, it demonstrates how we may research educational settings, materials, texts, and body-minds as entangled assemblages—continually co-constituting each other in messy and often uncertain sociomaterial practices.

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References

Ahmed, S. (2014). *The cultural politics of emotion*. Edinburgh: Edinburgh University Press.

Barad, K. (2003). Posthumanist performativity: Toward an understanding of how matter comes to matter. *Signs, 28*(3), 801–831.

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and mearning*. Durham: Duke University Press.

Bennett, J. (2010). *Vibrant matter: A political ecology of things*. Durham and London: Duke University Press.

Biesta, G. J. J. (2010). Why 'what works' still won't work: From evidence-based education to value-based education. *Studies in Philosophy and Education 29*, 491–503. https://doi.org/10.1007/s11217-010-9191-x.

Callon, M. (1986). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc bay. *Sociological Review Monograph, 32*(2), 196–233.

Callon, M., Law, J., & Rip, A. (Eds.). (1986). *Mapping the dynamics of science and technology: Sociology of science in the real world*. Basingstoke: Macmillan Press Ltd.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education* (6th ed.). Abingdon, Oxon: Routledge.
Coole, D., & Frost, S. (Eds.). (2010). *New materialisms: Ontology, agency, and politics*. Durham: Duke University Press.
Deleuze, G. (1988). *Spinoza: Practical philosophy* (R. Hurley, Trans.). San Francisco: City Lights Books.
Deleuze, G., & Guattari, F. (2013). *A thousand plateaus: Capitalism and schizophrenia* (B. Massumi, Trans.). London, New Delhi, New York and Sydney: Bloomsbury.
Dolphijn, R., & van der Tuin, I. (2012). *New materialism: Interviews & cartographies*. Ann Arbour, MI: Open Humanities Press.
Ellis, R. A., & Goodyear, P. (Eds.). (2018). *Spaces of teaching and learning: Integrating perspectives on research and practice*. Singapore: Springer.
Elmore, R. F. (2018). Design as learning: Learning as design. In R. A. Ellis & P. Goodyear (Eds.), *Spaces of teaching and learning: Integrating perspectives on research and practice*. Singapore: Springer.
Fox, N. J., & Alldred, P. (2017). *Sociology and the new materialism: Theory, research, action*. London and Thousand Oaks, CA: Sage.
Honan, E. (2014). Disrupting the habit of interviewing. *Reconceptualizing Educational Research Methodology, 5*(1). Retrieved from http://journals.hioa.no/index.php/rerm.
Lather, P., & St. Pierre, E. A. (2013). Post-qualitative research. *International Journal of Qualitative Studies in Education, 26*(6), 629–633. https://doi.org/10.1080/09518398.2013.788752.
Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press.
Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press.
Latour, B., & Woolgar, S. (1986). *Laboratory life: The construction of scientific facts*. Princeton, NJ: Princeton University Press.
Law, J. (1994). *Organizing Modernity*. Oxford and Cambridge: Blackwell.
Law, J. (2004). *After method: Mess in social science research*. Abingdon, OX: Routledge.
Law, J., & Mol, A. (1998). On metrics and fluids: Notes on otherness. In R. Chia (Ed.), *Organized world*. London: Routledge.
Law, J., & Mol, A. (2002). *Complexities: Social studies of knowledge practices*. Durham: Duke University Press.
MacLure, M. (2011). Qualitative inquiry: Where are the ruins? *Qualitative Inquiry, 17*(10), 997–1005. https://doi.org/10.1177/1077800411423198.
MacLure, M. (2013). The wonder of data. *Cultural Studies ↔ Critical Methodologies, 13*(4), 228–232. https://doi.org/10.1177/1532708613487863.
Mahat, M., Grocott, L., & Imms, W. (2017). *"In the real world…": Teachers' perceptions of ILEs. ILETC Phase 1 teacher workshops*. Retrieved from http://www.iletc.com.au/publications/reports/.
Masny, D. (2014). Disrupting ethnography through rhizoanalysis. *Qualitative Research in Education, 3*(3), 345–363. https://doi.org/10.4471/qre.2014.51.
Mol, A. (2002). *The body multiple: Ontology in medical practice*. Durham and London: Duke University Press.
Mulcahy, D. (2012). Affective assemblages: body matters in the pedagogic practices of contemporary school classrooms. *Pedagogy, Culture & Society, 20*(1), 9–27.
Mulcahy, D. (2016). 'Sticky' learning: Assembling bodies, objects and affects at the museum and beyond. In J. Coffey, S. Budgeon, & H. Cahill (Eds.), *Learning bodies: The body in childhood and youth studies*. Singapore: Springer.
Mulcahy, D. (2018). Assembling spaces of learning 'in' museums and schools: A practice-based sociomaterial perspective. In R. A. Ellis & P. Goodyear (Eds.), *Spaces of teaching and learning: Integrating perspectives on research and practice*. Singapore: Springer.
Mulcahy, D., & Morrison, C. (2017). Re/assembling 'innovative' learning environments: Affective practice and its politics. *Educational Philosophy and Theory, 49*(8), 749–758. https://doi.org/10.1080/00131857.2016.1278354.

Müller, M. (2015). Assemblages and actor-networks: Rethinking socio-material power, politics and space. *Geography Compass, 9*(1), 27–41. https://doi.org/10.1111/gec3.12192.
Neimanis, A. (2012). On collaboration (for Barbara Godard). *NORA—Nordic Journal of Feminist and Gender Research, 20*(3), 215–221. https://doi.org/10.1080/08038740.2012.703689.
Pickering, A., & Guzik, K. (2008). *The mangle in practice: Science, society, and becoming*. Durham: Duke University Press.
Plato. (1984). *The dialogues of Plato* (R. E. Allen, Trans.). New Haven: Harvard University Press.
Rømer, T. A. (2018). A critique of John Hattie's theory of visible learning. *Educational Philosophy and Theory*, 1–12. http://doi.org/10.1080/00131857.2018.1488216.
Somerville, M. (2016). The post-human I: Encountering 'data' in new materialism. *International Journal of Qualitative Studies in Education, 29*(9), 1161–1172. https://doi.org/10.1080/09518398.2016.1201611.
Watkins, M. (2010). Desiring recognition: Accumulating affect. In M. Gregg & G. J. Seigworth (Eds.), *The affect theory reader*. Durham and London: Duke University Press.
Watkins, M. (2011). Teachers' tears and the affective spatiality of the classroom. *Emotion, Space and Society, 4*(3), 137–143.
Watkins, M. (2017). Can space teach? Theorising pedagogies of social order. *Geographical Research, 55*(1), 80–88. https://doi.org/10.1111/1745-5871.12197.
Zembylas, M. (2007). The *specters* of bodies and affects in the classroom: A rhizo-ethological approach. *Pedagogy, Culture & Society, 15*(1), 19–35. https://doi.org/10.1080/14681360601162030.
Zembylas, M. (2017). The contribution of non-representational theories in education: Some affective, ethical and political implications. *Studies in Philosophy of Education, 36,* 393–407. https://doi.org/10.1007/s11217-016-9535-2.

Sarah Healy and Caroline Morrison (Australia) are both early career researchers who share an interest in theoretical concerns related to (new) materialities. Their respective research endeavours intersect on an onto-methodological level. In their contribution to this book, they put collaborative research into practice, exploring the in-between spaces of researchers, research contexts, and 'data' generated in a setting where teaching and learning occurs with palpable intensity—a taekwondo club. Prior to embarking on her PhD at The University of Melbourne, Carol was a primary teacher for 17 years and a primary school principal for 8 years. She is now researching policy practices of new generation learning environments in Melbourne Catholic schools. Sarah's background is in the creative industries and art education. Her PhD research, completed at The University of Melbourne in 2019, explored the ethics of pedagogic practices that occur 'in' intense learning environments. Sarah is currently a Research Fellow at The University of Melbourne's Graduate School of Education.

Innovative Learning Environments, Are They Inclusive? Why Evaluating the Speaking, and Acoustic Potential of the Space Matters

Leanne Rose-Munro

Abstract Innovative learning spaces are a platform primarily designed to support the activity of speaking, listening and learning. However, evidence suggests that nearly 10% of students attending mainstream schools in their local communities have hearing difficulties. This study explores the acoustic potential of innovative learning spaces (ILE's), and the impact of design affordances in terms of supporting the inclusion of students with hearing difficulties. The study highlights the importance of an acoustic platform that enables opportunity for all to participate in speaking and listening activity. In addition, the importance of student agency, the power to act and contribute to decision-making regarding the use and application of environmental affordances to enable student opportunity, inclusion and successful learning.

The Innovative Learning Environment

Innovative learning environments (ILEs) are speaking and listening spaces, a platform for student and teacher collaboration, creativity, complex problem solving and digital information gathering and sharing. Such learning spaces are auditory verbal environments where the primary information exchange occurs through speaking and listening activities (Munro, 2011). In designing innovative spaces there must be confidence that they are fit-for-purpose, account for diversity and ensure that speaking, listening and communication is accessible. The design principles of innovative learning spaces must enable the inclusion of all students and in particular a postulated 7–10% of students with suboptimal hearing abilities.

A shift away from traditional school design towards ILEs commenced in Australia between 2008 and 2012, when a government initiative known as Building the Education Revolution provided funding, predominantly junior schools, to build new learning spaces. Numerous new schools, particularly in the state of Victoria, were designed as technology enhanced learning environments consisting of a series of open-plan visually connected spaces with semi-connected 'breakout' areas. The

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spaces were designed to inspire student-centred active learning pursuits. Such pedagogical approaches value student collaboration and participation in socially oriented learning and twenty-first-century skill development. Figure 1 is an example of an Innovative learning environment (ILE) built during the BER 2008–2012.

The Problem

While an increasing body of research is exploring how teachers and students use such spaces, a gap exists in research that defines how these innovative environments include a broad range of students including those with speech and language delay, auditory processing disorders, hearing loss and noise sensitivity such as those with autism. The scale of students with hearing difficulties in mainstream education is demonstrated by Australian Hearing, a statutory authority constituted under the Australian Hearing Services Act 1999. At the time of this study services were provided to 68,296 eligible children and young Australians with hearing loss during 2012–2013 (Australian Hearing, 2013). There is significant evidence to suggests ILE's should be designed with high acoustic performance as a priority given that an overwhelming majority of these students attend mainstream schools in their local communities (Byrnes, 2011; Vosganoff, Paatsch, & Toe, 2011).

Listening in noise is a barrier to participating in conversation for many people, however of great concern is that research also indicates that students for whom English is an additional language, and those with speech and language difficulties, learning difficulties, cognitive disorders, attention disorders and behavioural problems also have difficulties listening and interpreting speech in noisy learning spaces (Massie & Dillon, 2006; Rowe & Pollard, 2003; Sharma, Purdy, & Kelly, 2009; Shield, Greenland, & Dockrell, 2010; Smaldino & Flexer, 2012; Snow & Powell, 2008). It is also widely reported that noisy environments adversely affect students with sensory disorders such as autism and vision loss by impacting cognition, heightening anxiety and diminishing access to clear speech (Anderson, 2001; Clark & Sorqvist, 2012; Guardino & Antia, 2012; Katte, Bergstroem, & Lachmann, 2013; Smaldino & Flexer, 2012). Collectively for the purpose of this research this cohort is referred to as students with hearing difficulties.

The study of acoustics, defined as the properties or qualities of a room or building that determine how sound is transmitted in it, have highlighted detrimental effects of noisy 'classrooms' on learning (Shield et al., 2010). Little is known about noise and acoustics in ILEs, as the interrelationships of pedagogy, innovative spatial design and technology are not yet broadly investigated and reported, and in particular how these elements play a role in creating new experiences for students with hearing difficulties (Brown & Eisenhardt, 1997; Glaser & Strauss, 1967; Spencer & Marschark, 2010).

Communication modalities between the inhabitants of learning spaces has changed significantly overtime due to the embedded use of technology in educational settings. Furthermore, advances in design and construction materials such as acoustic attenuation, speech reinforcement systems and mobile device use challenge

Fig. 1 Innovative Learning Environment in an Australian primary school

the notion that communication in open-plan space is inhibited by unwanted noise. Collectively this highlights the fundamental importance of evaluating innovative learning environments ILEs to ensure that they offer enhanced opportunity for inclusion and that researchers are able to define determinants and affordances required for successful habitation.

Inclusiveness of the Innovative Learning Environment

It is widely recognised that in mainstream learning environments there is a diverse range of students with a variety of learning potentials and abilities. The term 'mainstream' implies that students will need to adapt to fit into the majority culture, and inclusion signifies that the programme will make adaptions to fit the needs of all students in the classroom (Stinson & Foster, 2000). In determining the elements in an ILE that enable inclusion, it is important to consider the quality of the student's experiences while accounting for opportunities that help or hinder participation. Kay asserts it is unfair and unproductive to expect students to meet new and higher expectations in twenty-first-century learning spaces if the supporting infrastructure is not there (as cited in Bellanca & Brandt, 2010).

In a mixed method multiple case study research project involving three students with hearing difficulties in one ILE, an interdisciplinary approach using methods from acoustical engineering, audiology and social science research were employed to gain insight into the environment under investigation (Imms, Cleveland, & Fisher, 2016). A key driver of this study was to understand what supporting infrastructure and affordances enabled communicative experiences of students with hearing difficulties in an open-plan environment.

The methodological approach aimed to explore issues of inclusion for students with hearing difficulties while accounting for the complexity of variables that impact the performance standard of the learning environment. Student experience is situated at the centre of the learning environment evaluation process. In this study Radcliffe's (2009) Pedagogy, Space, Technology Learning Environment Evaluation Framework was utilised as grounding for this research because it offers a simple framework that identifies patterns in what institutions are trying to achieve, the ways in which they do this, and how they evaluate success. The questions asked within the framework can be tailored to meet particular ways of doing work, and the process is one which is 'inherently self-documenting and aids the elicitation of lessons learned for future projects' (Radcliffe, 2009, p. 14). Complimenting this approach Brinkerhoff's (2005) Success Case Methodology that explores 'what works' in times of fast-paced change while accounting for the 'value-add' of learning. As a result of this emergent approach, the evidence collected assisted in identifying particular design, technological and pedagogical elements in the ILE, which impact the inclusion of students with hearing difficulties in ILE's.

Methods

In this study, the ILE under investigation was an open-plan primary school and 3 students with diagnosed hearing difficulties were the cases. To begin, the building structure was tested to determine the acoustic performance, and how noise was mediated by the design affordances of classroom spaces and breakout areas. An affordance can be described as a quality of an object or an environment that allows an individual to perform an action (Gibson, 1977; Wright & Parchoma, 2011). For instance, during noisy learning activities the wall structures were tested to determine if unwanted sounds were absorbed of if sound echoed and bounce off walls creating additional interference in accessing clear speech in the environment.

After determining the baseline acoustic performance of various spaces within the open-plan environment, the focus switched to collection of qualitative data using photo-elicitation and semi-structured interviews with the case study students. It was fundamentally important to establish the student's perceived level of inclusion, the quality of *their* experiences in the learning environment and *their* interpretation of such. This evidence was then triangulated against the acoustic data. Affordances are also properties of the system, as perceived by the user, that allow certain actions to be performed and which encourage specific types of behaviour (Cox et al., 2004). Affordances speak directly to the quality of an experience as a result of an action, and in doing so go beyond the current rhetoric of inclusive education policies that speak to the notion of reasonable adjustments (Disability Discrimination Act 1992, 1992; Disability Standards for Education 2005, 2005). Given the absence of research on inclusion of 'mainstreamed' students with hearing difficulties in open-plan ILEs, a multifaceted, multi-lens approach to data collection was taken to ensure reliability, validity and to mitigate researcher bias while evaluating student perceptions about the environment (Blackmore, Bateman, Loughlin, O'Mara, & Aranda, 2011; Spencer & Marschark, 2010).

The study focus was not on the hearing deficit of the student but rather on the students' experience in the ILE, and how the performance of the environment mediated inclusion of these students. As such further key research questions included:

- How are teachers planning the use of the environment to promote inclusion?
- How and in what ways is communication facilitated?
- What elements within the open-plan learning environment facilitate opportunity for participation in speaking and listening?

In addition, the subsidiary aims of the study were to:

- Investigate the environment's technology and acoustical affordances and properties to determined their influences on inclusion and subsequently what affordances should be adopted as best practice initiatives.
- Investigate the teachers' and students' preferential use of places to communicate within the learning space to determine how innovative learning environments could be best utilised for optimal access to speaking and listening activities.

This study and the approach taken highlighted the fundamental purpose of coming together in a face-to-face space to learn, and draws attention to:

- The importance of an acoustic platform that enables opportunity for all to participate in speaking and listening activity.
- Student agency, the power to act and contribute to decisions about how best one might learn, and the environmental affordances that enable opportunity and success.

The emergent methodological approach enabled the capture of convergent and divergent thinking regarding the intersection of the elements of pedagogy, space and technology in the innovative environment, and the subsequent impact upon inclusion of students with hearing difficulties.

Acoustic Findings

Acoustic quantitative data is fundamentally important data that corroborates or explains what helps or hinders inclusion in communicative opportunities for the inhabitants of ILEs. In a mixed methods evaluation design, substantive inferences about the affordances of the environment are made and further interrogated using qualitative methods such as semi-structured interviews, focus groups, structured observations and photo-elicitation (Moss, 2008).

In this study a noise logger, an acoustical measurement tool, logged the average equivalent background noise measured in decibels over time within a set position in the ILE. This measure gave an indication of the typical background noise levels that students and teachers commonly experienced within this space over time. Noise was logged at an average of 75 decibels (dB). It is reported that for intelligible speech to be heard by students with normal hearing abilities at a distance of 2–3 m from the presenter, background noise should not exceed 55 dB (Flexer, Smaldino, & Crandell, 2005) and the voice of the presenter be 20 dB above background noise. Effectively a teacher would have to shout at 95 dB for this condition to be met (Fig. 2).

Reverberation times were recorded; these are a simple indication of how the building performs in terms of absorbing sound reflections or echoes. The breakout spaces in the ILE recorded between 0.4 standards >0.6 RT (reverberation time), satisfying recommended RT for 'classrooms' (AAAC, 2010). However, the adjacent open-plan common learning area recorded 1.1 RT, far exceeding recommendations.

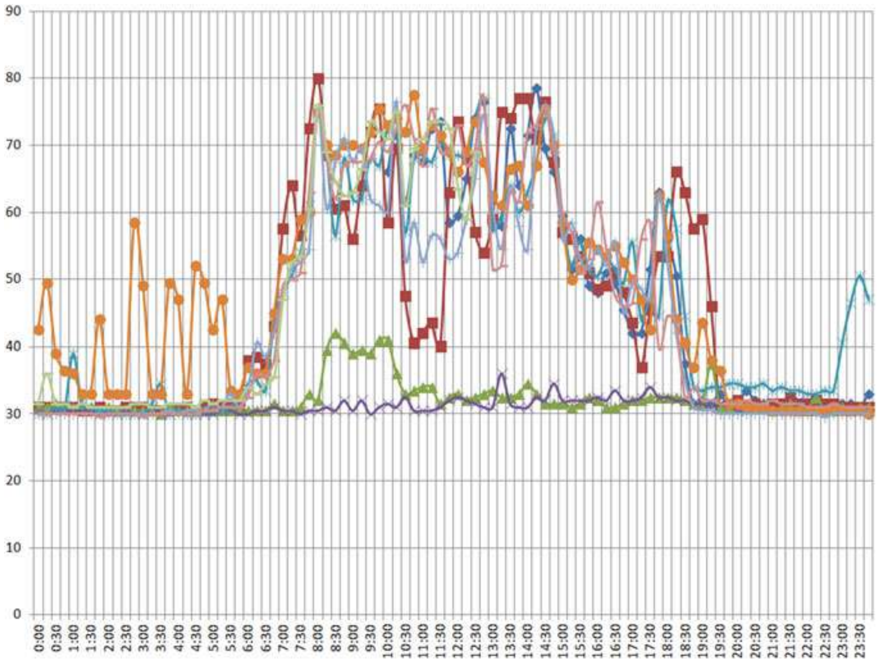

Fig. 2 Graph 1 of noise logger data, average noise level reading 75 dBA, administered by Marshal Day Acoustics Pty Ltd

This noise often spilt into the breakout zones and was reported as ‘an annoying source of disruption’ by a case study student, this sentiment was repeated by other students and teachers throughout the study.

Finally, innovative equipment was administered by an acoustical engineer that captured the clarity (C50) of speech sounds at points within the learning environment. These measurements are depicted as an Iris plot™ in graph 2 (Fig. 3) and graph 3 (Fig. 4), which showed the most direct signal from the source to receiver (red spike) and interfering sound reflections (blue and green spikes). This data enabled the identification of optimal positions for presenting when addressing students in speaking and listening activities in the ILE.

Graphs 2 and 3 show a comparison of speech clarity C50 in 2 different locations depicted visually by Marshall Day Iris plot™. This data is fundamental to the formulation of Standards that enable equitable access for those with hearing difficulties in buildings such as public meeting spaces, and in particular education facilities. For example, the Association of Australian Acoustical Consultants (AAAC) recommend the following acoustical design conditions for classrooms, outlined in Table 1, be adopted as a Standard for achieving hearing accessibility to clear speech in classrooms.

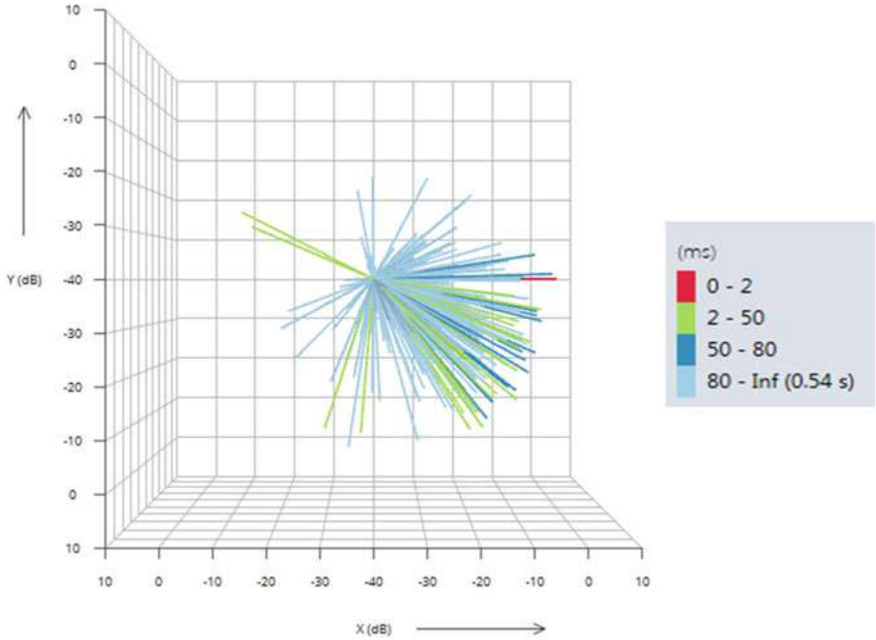

Fig. 3 Graph 2 of poor speech clarity

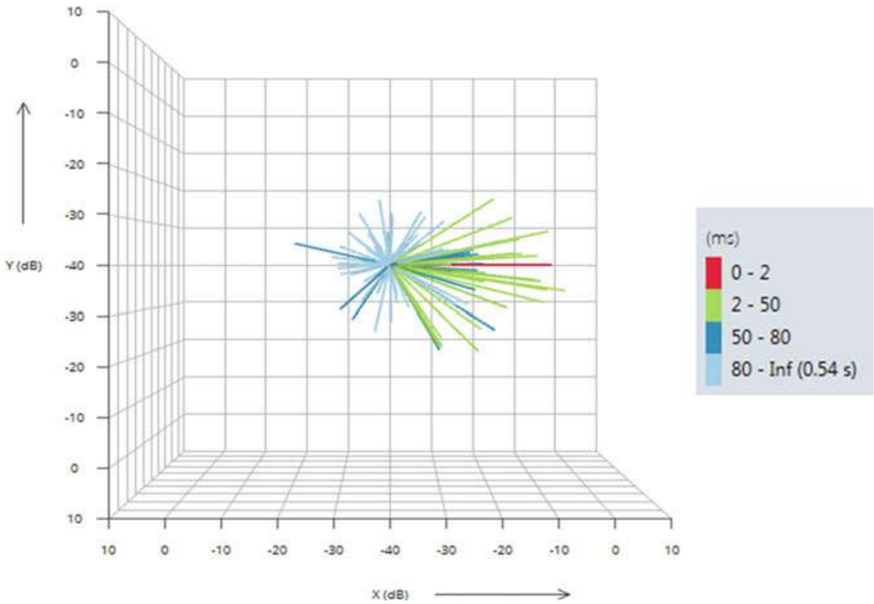

Fig. 4 Graph 3 of good speech clarity

Table 1 Guideline for educational facilities acoustics (AAAC, 2010)

Recommended classroom acoustical design conditions Association of Australian Acoustical Consultants Guideline for Educational Facilities Acoustics (2010)
• A spoken voice level at least 15 dB above the background noise level throughout the room; • Background noise levels of 30–40 dBA, or less when unoccupied; • Overall sound levels (consisting of teaching voice and student voice) no greater than 65–70 dBA throughout the room; • Sound-absorbing materials, placed to minimise reverberation to less than 0.4 s in primary teaching spaces and 0.6 s in secondary teaching spaces, including at least 40% absorptive treatment on the ceiling; • A Speech Transmission Index STI >0.6 in open-plan teaching and study spaces For the further case of students with special hearing requirements the following acoustical design conditions should also be satisfied • Reverberation time of 0.4 s or less • Signal to noise ratio of greater than 20 dB

Student Voice Findings

In this study, the acoustic data provided a context to better understand student voice gained through the qualitative case study approach. While the noise logger demonstrated excessive noise present at a specific location, it was found that in particular locations the teachers voice was clearer. This was attributed to the shape, configuration and structural elements in the room, such as a noise control acoustic rated wall panelling, lower ceiling height with acoustic rated tiles, and carpet and soft furnishings that dampened noise. When students were given agency, the power to act, (Van Lier, 2008) they intuitively positioned themselves in the spaces that had been empirically identified as having good acoustic affordance, and supported greater accessibility to clear speech. Corroborating this finding in semi-structured interviews using photo-elicitation, the students revealed that these spaces were their favourite spaces to retreat to when given freedom to do so, in particular during independent learning times.

When excessive noise was generated by surrounding student and teacher activity, technology such as iPads and interactive whiteboards acted as communication tools providing visual clues and prompts. This enhanced the case study students' accessibility to learning. While these tools were not a substitute for speech, they provided a bridge that enabled students an avenue to independently interpret the requirements of a learning activity. Technology devices also provided a level of anxiety reduction by engaging the case study students in learning via multi-modal pathways. 'Special' access to technology tools gave comfort to the students with hearing difficulties who at times completed tasks before other students not identified as having a hearing difficulty. While technological affordances were present and in abundance in the ILE, student use was restricted by the teachers who tended to deploy tech tools as 'an additional learning activity' rather than an embedded part of learning. Similarly, the ILE was fitted with a sound-field system, consisting of a number of distributed low-level amplification speakers, a teacher worn microphone with a student pass around hand-held microphone. The sound-field speakers lifted the voice of the presenter above the background noise, overcoming the distance from the teacher-to-background noise ratio for students. When the sound-field system was in use noise generation momentarily abated in the immediate area as well as co-located spaces. This Lombard effect, the involuntary tendency of speakers to increase their vocal effort when speaking in loud noise to enhance the audibility, was resolved by the sound-field system. Teachers no longer shouted and competed with each other to be heard when using the system. While all teachers acknowledged the benefits of the use of such technology, it was spasmodically used. This frustrated one of the case study students who took it upon herself to constantly remind teachers to use it.

Developing a culture of trust in working with others was identified by the case study students as fundamental to their inclusion in the ILE. Students said when teachers trusted their judgement and supported their choice to move to particular spaces and work with others, they felt more included because they could understand speech and the nature of the learning activity more clearly. The teachers however said they were unaware that this example of student agency was an important factor for including the case study students in various activities. There were many times, particularly when noise escalated, that student agency was taken away and didactic teaching prevailed. At these times, the case study students could not access their learning buddy, reposition themselves to acoustically supportive positions or use technology to bridge the learning activity. Noise appeared to be the trigger for reverting to didactic teacher-centred practices. Teachers reported feelings of exhaustion after days of working in noisy spaces, justifying decisions to limit collaborative activities in the open-plan area and retreat to the breakout areas for quieter teacher-directed learning activities, where they felt they could have an impact on control noise.

Discussion, Evaluating Inclusiveness of Innovative Learning Environments

Today more than ever in a student's learning journey it is critical that all have opportunity to participate and develop the ability to collaborate, connect to others, creatively problem solve and transfer content knowledge to many contexts. Highly effective communication skills are fundamental for participation in lifelong education and future job markets. Given this, it can be said that traditional student success measures such as student academic achievement data may not capture the breadth of 'student success' in an ILE. For example, an individual student may make significant gains in terms of progress even though the student may be below or just reaching bench-mark standards.

Deployment of effective design affordances in ILE's involves the process of collectively translating ideas and inventions into physical, technological and pedagogical services that create 'value'. The concept of changing learning landscapes is not new, however evidencing the connection between learning environment and 'learner success' is relatively emergent in the research literature (Imms et al., 2016). 'Value' is dependent upon effectively addressing individual learner preferences and styles such that all have an opportunity to participate, 'including' students with hearing difficulties. Given this, the validity of the 'value-add' of design affordances might be considered in-part the physical and technological attributes of a learning space that prompt specific advantageous learning behaviours observable in a research setting; for example, active participation in face-to-face communicative experiences in an ILE. Such behaviours are observed and affirmed through relevant response and interaction to conversations. However, when accessibility to intelligible speech is challenged behaviours such as withdrawal and distraction from key conversations may be observed (Stake, 1995; Moss, 2008). When this occurs, learning becomes less inclusive and opportunity to participate may momentarily cease unless an alternative learning activity is offered. While protagonists of social science research methodology may argue various mitigating factors contribute to disengagement, corroborating acoustical data support the inference that a poor acoustic platform is a key element excluding students from active participation in face-to-face learning activity such as collaborative tasks reliant on verbal communicative experiences (Howard, Munro, & Plack, 2010).

In this study when student agency was given, self-advocacy and self-regulation mechanisms were exhibited by students, i.e. the students explored their environment, finding spaces, places and multi-modal platforms that supported their learning, it was in such times that the aspirations of twenty-first-century skill development were observed. Students and their learning buddies co-constructed knowledge communicating through multi-modal pathways not reliant on the transmission of speech but rather through text, pictures, model materials and technology devices.

Informed student voice relates to the notion that as key inhabitant's students are well positioned to provide feedback on the spatial attributes and affordances that enrich their learning and the elements that enable inclusion and participation (Van Lier, 2008, Gibson, 1977; Pruyn, 1999). As informed student voice emerges, it can be used to cultivate design affordances and pedagogic and operational practices that enhance inclusion through enabling activation of diverse learning styles and preferences in the ILE.

Conclusion

As more research studies emerge on ILE's researchers note that particular space designs or typologies elicit particular human behaviours and responses to participation in learning activities. What is known is that collaborative learning activities generate noise and noise is a factor that impacts communicative experiences (Munro 2011). By varying the spatial form, layout of a room and incorporation of acoustic attenuation and technological affordances noise can be controlled such that it minimises negative impacts on learning efficacy (Guardino & Anita, 2012).

Fig. 5 Example of working with a trusted other in a 'Nook'

For example, the discovery of the value of 'acoustic nooks' (sensory reduction zones within the learning environment that mediated noise) and 'the trusted other' (a person the case study students identified as a good peer who could aid their learning) were identified as affordances of the ILE that enabled inclusion of students. See Fig. 5.

Rigorous evaluation of ILEs presents a plethora of opportunity for many stakeholders invested in enhancing educational outcomes for all students. Design principles associated with inclusive fit-for-purpose speaking and listening environments have yet to be broadly identified in the context of education building infrastructure. While many studies have demonstrated that excessive noise has detrimental effects on learning, assumptions regarding open-plan learning environments based on past research may not apply in these technology rich spaces that employed the use of innovative acoustic materials, design elements and student-centred pedagogies. Interdisciplinary approaches to evaluation may assist in closing the gap between students with and without learning disabilities and differences. This is because these types of methods critique the interplay between numerous elements acting in synergy. Knowing how to balance particular evidence-based elements leads to enhanced inclusion and greater opportunity for to student access to learning.

This study used a multi-lens approach that valued collaboration and interdisciplinary thinking, which sits within the philosophical framework of twenty-first-century learning environments. Broad approaches such as those described above are supported by Kalikoff who put the case for a mosaic approach that involved the implementation of a series of textured and complementary evaluation strategies that aimed to provide reliable and detailed information about what was being accomplished in the context of the environment under investigation (Kalikoff, 2001).

While it was found that particular identified affordances enhanced inclusion of students with hearing difficulties in the ILE, there were many instances where students were inadvertently excluded. There is an ongoing imperative to identify and embed design principles for learning spaces that account for high-quality noise control and professional learning for teachers, administrators and designers involved in developing and operationalising such spaces. As such, return on investment of rigorous evaluation of learning spaces is validated by assurance that identified design principles lead to development of exemplar fit-for-purpose learning environments that offer opportunity for all students, in particular those with hearing difficulties to be actively and successfully included in learning.

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References

Anderson, K. (2001). Kids in noisy classrooms: What does the research really say? *Journal of Educational Audiology, 9,* 21–33.

Association of Australian Acoustical Consultants Guideline for Educational Facilities Acoustics (2010, September). Retrieved from www.aaac.org.au8/8/2017.

Australian Hearing. (2013). *2012–2013 annual report*. NSW, Australia: Australian Hearing.

Bellanca, J., & Brandt, R. (2010). *21st century skills; Rethinking how students learn.* Bloomington, IN: Solution Tree Press.

Blackmore, J., Bateman, D., Loughlin, J., O'Mara, J., & Aranda, G. (2011). *Research into the connection between the built learning spaces and student outcomes.* Melbourne: Department of Education and Early Childhood Development.

Brinkerhoff, R. (2005). The success case method: A strategic evaluation approach to increasing the value and effect of training. *Advances in Developing Human Resources, 7,* 86–101. https://doi.org/10.1177/1523422304272172.

Brown, S., & Eisenhardt, K. (1997). The art of continuous change: Linking complexity theory and time—Pace evolution in relentlessly shifting organizations. *Administrative Science Quarterly, 42,* 1–34.

Byrnes, L. (2011). Listening to the voices of students with disability: What do adolescents with hearing loss think about different educational settings? *Deafness and Education International, 13*(2).

Clark, C., & Sorqvist, P. (2012). A 3 year update on the influence of noise on performance and behaviour. *Noise & Health, 14*(16), 292–296.

Cox, M., Webb, M., Abbott, C., Blakely, B., Beauchamp, T., & Rhodes, V. (2004). *ICT and pedagogy: A review of the research literature.* A report to the DfES. Unknown Publisher.

Disability Discrimination Act 1992. (1992).

Disability Standards for Education 2005. (2005).

Flexer, C., Smaldino, J., & Crandell, C. (2005). *Sound field amplification applications to speech perception and classroom acoustics* (2nd ed.). Canada: Thomson Demar Learning.

Gibson, J. (1977). The theory of affordances. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting and knowing: Toward an ecological psychology*. Oxford: Oxford University Press.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research.* London: Weidenfeld and Nicholson.

Guardino, C., & Antia, S. (2012). Modifying the classroom environment to increase engagement and decrease disruption with students who are deaf or hard of hearing. *Journal of Deaf Studies and Deaf Education, 17*(4), 518–533.

Howard, C., Munro, J., & Plack, C. (2010). Listening effort at signal to noise ratios that are typical of the school classroom. *International Journal of Audiology, 49,* 928–932.

Imms, W., Cleveland, B., & Fisher, K. (2016). *Evaluating Learning Environments: Snapshots of emerging issues, methods and knowledge* (W. Imms, B. Cleveland, K. Fisher, Eds.). Rotterdam: Sense Publishers.

Kalikoff, B. (2001). From cohesion to collaboration: A mosaic approach to writing center. *Writing Lab Newsletter, 26*(1), 5–7.

Katte, M., Bergstroem, K., & Lachmann, T. (2013). Does noise affect learning? A short review on noise effects on cognitive performance in children. *Frontiers in Psychology, 4*(578), 142.

Massie, R., & Dillon, H. (2006). The impact of sound-field amplification in mainstream cross-cultural classrooms: Part 1 Educational outcomes. *Australian Journal of Education, 50*(1), 62–77.

Moss, J. (2008). *Researching education visually-digitally-spatially*. Rotterdam, The Netherlands: Sense Publishers.

Munro, J. (2011). *Teaching oral language building a firm foundation using ICPALER in the early primary years*. Camberwell: ACER Press.

Pruyn, M. (1999). *Discourse wars in Gotham-West, a Latino immigrant urban tale of resistance and agency*. Boulder: Westview Press.

Radcliffe, D. (2009). A Pedagogy-Space-Technology (PST) framework for designing and evaluating learning spaces. In D. Radcliffe, H. Wilson, D. Powell, & B. Tibbetts (Eds.), *Learning spaces in higher education: Positive outcomes by design. Proceedings of the Next Generation Learning Spaces 2008 Colloquium* (pp. 9–16). Brisbane, Australia: University of Queensland.

Rowe, K., & Pollard, J. (2003). Auditory processing: Literacy, behaviour and classroom practice. *ACQ: Acquiring Knowledge in Speech, Language and Hearing, 5*(3), 134.

Sharma, M., Purdy, S., & Kelly, A. (2009). Comorbidity of auditory processing, language and reading disorders. *Journal of Speech and Hearing Research, 52,* 706–722.

Shield, B., Greenland, E., & Dockrell, J. (2010). Noise in open plan classrooms in primary schools: A review. *Noise & Health, 12*(49), 225–234.

Smaldino, J., & Flexer, C. (2012). *Handbook of acoustic accessibility: Best practices for listening, learning and literacy in the classroom.* New York, NY: Thieme.

Snow, P. C., & Powell, B. C. (2008). Oral language competence, social skills and high risk boys: What are juvenile offenders trying to tell us? *Children and Society, 22,* 16–28.

Spencer, P., & Marschark, M. (2010). *Evidence-based practice in educating deaf and hard-of hearing students. Professional perspectives on deafness: Evidence and applications*. New York, NY: Oxford University Press.

Stake, R. (1995). *The art of case study research.* London: Sage.

Stinson, M. S., & Foster, S. (2000). Socialization of deaf children and youths in school. In K. P. Meadow-Orlans, P. E. Spencer, C. Erting, & M. Marschark (Eds.), *The deaf child in the family and at school: Essays in honor of Kathryn P. Meadow-Orlans* (pp. 191–209). Mahwah, NJ: Lawrence Erlbaum Associates.

Vosganoff, D., Paatsch, L., & Toe, D. (2011). The mathematical and science skills of students who are deaf or hard of hearing educated in inclusive settings. *Deafness and Education International, 13*(2), 70–88.

Wright, S., & Parchoma, G. (2011). Technologies for learning? An actor-network theory critique of 'affordances' in research on mobile learning. *Research in Learning Technology, 19*(3), 247–258.

van Lier, L. (2008). Agency in the classroom. In Lantolf, J. P. & Poehner, M. E. (Eds.) (2008), *Sociocultural theory and the teaching of second languages.* London: Equinox.

What About Interaction Geography to Evaluate Physical Learning Spaces?

Ben Rydal Shapiro

Abstract This paper reviews and explores how interaction geography, a new approach to visualize people's interaction over space and time, extends current approaches to evaluate physical learning spaces. This chapter begins by reviewing representations produced using interaction geography to study visitor engagement and learning in a museum. In particular, this review illustrates *Mondrian Transcription*, a method to map people's movement and conversation over space and time, and the *Interaction Geography Slicer (IGS)*, a dynamic visualisation tool that supports new forms of interaction and multi-modal analysis. Subsequently, this chapter explores how interaction geography may advance the evaluation of physical learning spaces by providing dynamic information visualisation methods that support more expansive views of learning and the evaluation of the alignment between space and pedagogy. This chapter concludes by outlining significant limitations and next steps to expand interaction geography to evaluate physical learning spaces.

Introduction

Historically, the evaluation of physical learning spaces has relied on concepts and methods from professional design disciplines (e.g. architecture, urban planning) to assess how the physical design of space conditions the measureable learning performance of people. For example, post-occupancy evaluation (Zimring & Reizenstein, 1980; Zimmerman & Martin, 2001) is often used to evaluate how the physical structure of spaces (e.g. as represented through methods of space syntax or building information modelling) influences people's learning performance on standardised tests or "behavior performance scores" (Wineman, Peponis, & Dalton, 2006; Hillier, 2008; Peponis, 2005; see Cleveland & Fisher, 2014 for full review).

On one hand, this work continues to demonstrate that there are relations between the physical environment and learning despite "many sweeping claims about the

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possible effects of various aspects of learning spaces on student learning that are not substantiated empirically" (Tanner 2000 as cited in Blackmore et al. 2011, pg. 5; also see Imms, Cleveland & Fisher, 2014; Tanner, 2009). On the other hand, this work provides little explanation as to how or why these relations are observed in correlational analysis.

Recent research has defined three distinct areas that must be addressed to advance the evaluation of physical learning spaces. First, new research methods need to be developed that are "capable of controlling the complex variables inherent to space and education" (Imms & Byers, 2017). Second, concepts and methods used to evaluate physical space need to be better integrated with a broader understanding of learning theory (Ellis & Goodyear, 2018) to include, for example, social practice, and sociocultural theories of learning (Lave & Wenger, 1991; Cole, 1996). Third, research needs to develop ways to assess people's participation at a scale and in ways that support working with professional practitioners to study and design for the alignment between space and pedagogy (Cleveland & Fisher, 2014).

This chapter reviews and explores how interaction geography, a new approach to describe, represent, and interpret people's interaction over space and time (Shapiro et al. 2017), provides one way to address these needs and extend current approaches to evaluate physical learning spaces. This chapter begins by reviewing representations produced using interaction geography to study visitor engagement and learning in a museum. In particular, this review illustrates *Mondrian Transcription*, a method to map people's movement and conversation over space and time, and the *Interaction Geography Slicer (IGS)*, a dynamic visualisation tool that supports new forms of interaction and multi-modal analysis. Subsequently, this chapter explores how interaction geography may advance the evaluation of physical learning spaces by providing dynamic information visualisation methods that support more expansive views of learning and the evaluation of the alignment between space and pedagogy. This chapter concludes by outlining significant limitations and next steps to expand interaction geography to evaluate physical learning spaces.

Interaction Geography in a Museum

The following sequence of representations reviews interaction geography and in particular, methods of interaction geography that include Mondrian Transcription and the IGS as described by Shapiro et al. (2017). Though these representations use data from a museum context, this review intends to communicate the potential application of interaction geography more generally, to a variety of settings. Notably, these representations are complex and necessitate new ways of reading the physical environment, people's activity, and people's movement over space and time simultaneously. For high resolution/colour representations please see https://benrydal.com.

Figure 1 maps the movement of a six-year-old boy, Blake (blue path), and his sister's fiancé, Adhir (orange path), as they visit a museum gallery together. Also

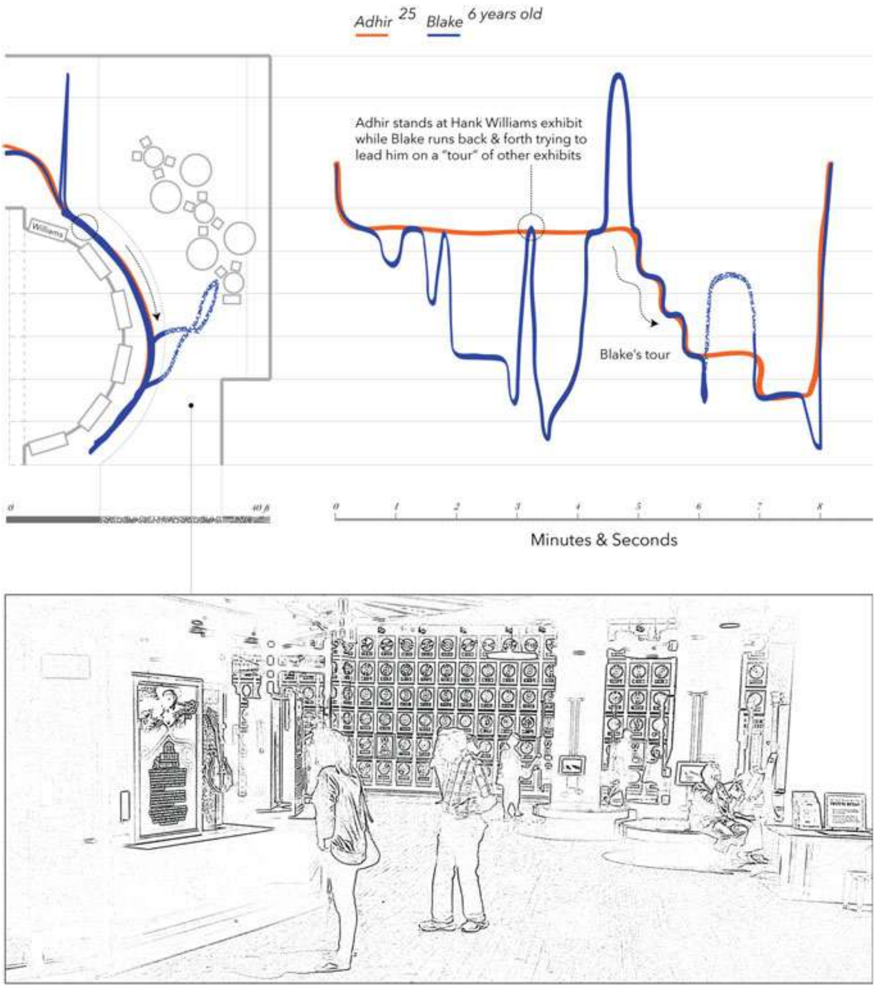

Fig. 1 Adhir and Blake's movement across a museum gallery space is shown over space and space-time. Copyright © by Ben Rydal Shapiro. Reprinted by permission

included in the figure is a rendering showing the gallery space from a point marked on the floor plan. The left of the figure or "floor plan view" shows their movement over a floor plan of the gallery space (i.e. looking down on the space). This view shows where Blake and Adhir go within the gallery space. The right, or "space-time view" (Hagerstrand, 1970) extends Blake and Adhir's movement on the floor plan horizontally over time. This view shows how they interact with exhibits and one another over time. For example, the space-time view shows that after entering the gallery space (top left of floor plan view and beginning of space-time view), Adhir and Blake walk together towards an exhibit about Hank Williams (marked on the floor plan). Subsequently, Adhir stands for almost 5 min at the Hank Williams exhibit, as indicated by his horizontal orange path in the space-time view that extends from approximately minutes 0–5 and corresponds to the vertical position of the Hank Williams exhibit in the floor plan view. In the meantime, while Adhir is standing, Blake is moving quickly (apparently running) back and forth across the gallery space (i.e. across the semi-circle of exhibits on the floor plan) in multiple attempts to draw Adhir away from the Hank Williams exhibit. After four failed attempts, Blake finally succeeds in leading Adhir on a tour of other exhibits in the gallery, indicated by their intertwined paths from approximately minutes 5–6. The change in line pattern in Blake's path distinguishes between different horizontal areas of space on the floor plan providing some description of horizontal movement on the floor plan in the space-time view (this technique has limitations but becomes more relevant when more people are shown).

Figure 2 extends the previous figure. The figure is a screenshot from the IGS and illustrates Mondrian Transcription. Namely, the figure maps the movement and conversation of all five members of a family (called the "Bluegrass Family"), including Blake and Adhir but also Blake's brother Jeans (green), Blake's sister Lily (yellow), and Mae, referred to as "Mom" (purple, the mother of Blake, Jeans and Lily). The top half of the figure shows the family's movement and the bottom half shows their conversation in relation to their movement (i.e. the family's movement is shown in grey beneath their conversation to link the two halves of the figure). Conversation is transcribed and organised in a manner that draws from and extends conventions of conversation and interaction analysis (see Jordan & Henderson, 1995; Erickson, 2004; Kendon, 1990).

First, each turn at talk is shown as a coloured line to indicate which family member speaks that conversation turn (indentations indicate overlapping speech). Second, coloured lines of talk are gathered into boxes that group topically related sequences of conversation turns and movement (e.g. in this case, usually related to artefacts/musicians in this setting). Thus, in the space-time view, each box marks the start, duration, and end of a sequence. In the floor plan view, conversation turns and separate (in time) sequences accumulate within regions of gridded space–the box thickness in the floor plan view increases with each repeated sequence within a region of space. For example, the region of space around the Hank Williams exhibit has the largest number of conversation turns (as indicated by the many coloured lines of talk) and is enclosed by a dense box that reflects five separate (in time) sequences occurring at the Hank Williams exhibit. The highlighted sequence (i.e. readable conversation) in the space-time view expands the conversation turns of one particular sequence. This is a type of "operation" made possible by the IGS (i.e. in the IGS a user can hover over conversation lines to magnify/read conversation turns). In the figure, the grouping of these sequences is determined in one particular manner, but Mondrian Transcription allows conversation and movement to be grouped in a variety of ways and also potentially supports a variety of transcript conventions (e.g. to show the direction of speech).

This figure provides ways to interpret people's interaction and movement in relation to the physical environment. For example, the highlighted sequence in the figure from approximately minutes 4–5 in the space-time view encompasses a complex

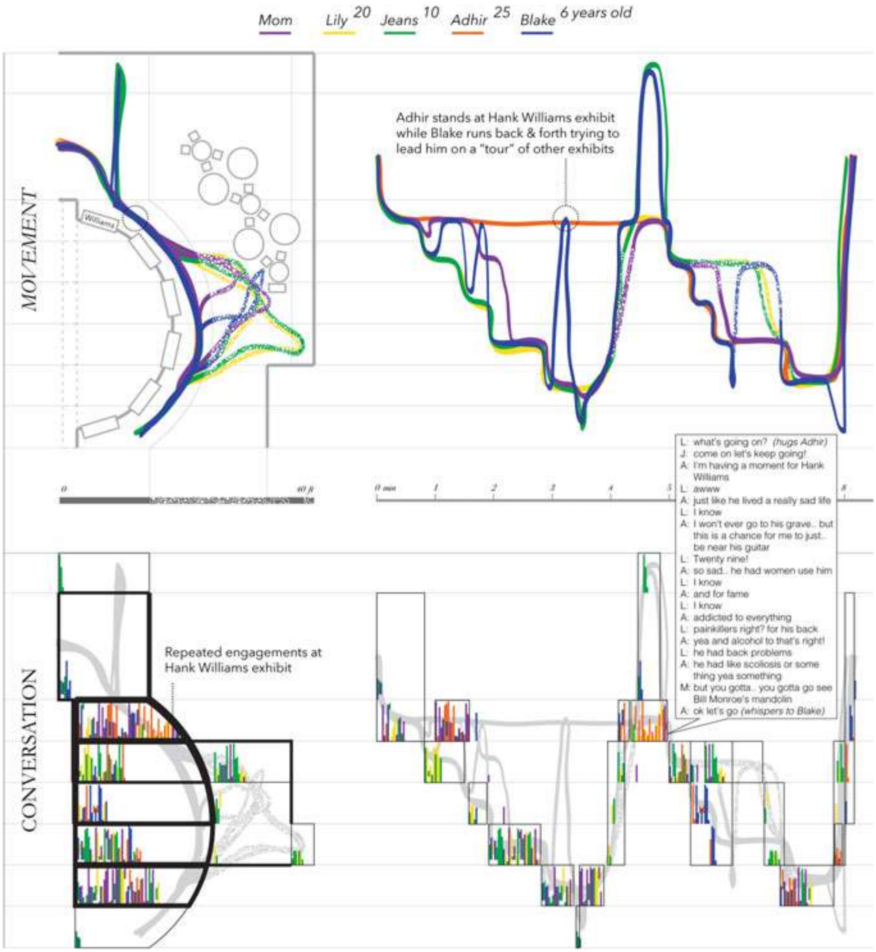

Fig. 2 Mondrian transcript of the Bluegrass Family's interaction geography. Copyright © by Ben Rydal Shapiro. Reprinted by permission

mesh of activity around the Hank Williams exhibit. As described by Shapiro et al. (2017), reading this sequence of activity in relation to the rest of the figure shows how:

(1) Lily soothes the emotions of Adhir (her fiancé) by hugging and consoling him as he compares the Hank Williams exhibit to a "grave" (in line 8).
(2) Jeans gives Lily and Adhir privacy by leading a frustrated Blake away from the Hank Williams exhibit (the extension of their movement paths upwards in the floor plan and space-time views indicating their movement away from the exhibit).

(3) Blake and Jeans re-join Lily and Adhir as Adhir continues to share his own account of Hank William's painful life.
(4) Mae (Mom), who has been standing near Adhir and Lily and observing her family's interaction, helps Blake lead Adhir on a tour of other exhibits by saying to Adhir, "but you gotta.. you gotta go see Bill Monroe's mandolin" (in lines 22–23).
(5) Evidently fully aware of Blake's ongoing project to lead a tour, Adhir whispers to Blake, "ok let's go" and they move forward together to the next Bluegrass artist (at the end of the highlighted conversation).

In other words, reading these interpretations in relation to the rest of the figure reveal phenomena (e.g. Blake's tour and Adhir's persistent engagement with the Hank Williams exhibit) not visible without methods of interaction geography. These interpretations require multi-scalar ways to (a) analyse structural properties of settings alongside visual patterns of people's conversation and movement, (b) read individual conversation turns and situate these conversation turns with respect to simultaneous conversations occurring in different parts of a museum gallery space, and (c) not communicated here but possible within the IGS, to watch/listen to video/audio from the perspective of each family member gathered as part of this research (i.e. Mondrian Transcription/the IGS syncs multi-perspective audio and video if available to these visualisations).

Figures 3 and 4 are screenshots from the IGS displayed in a small multiple format (Tufte, 1990). Figure 3 shows continuous movement for each family/group whereas Fig. 4 shows "personal curation" or traces of movement where visitors are using

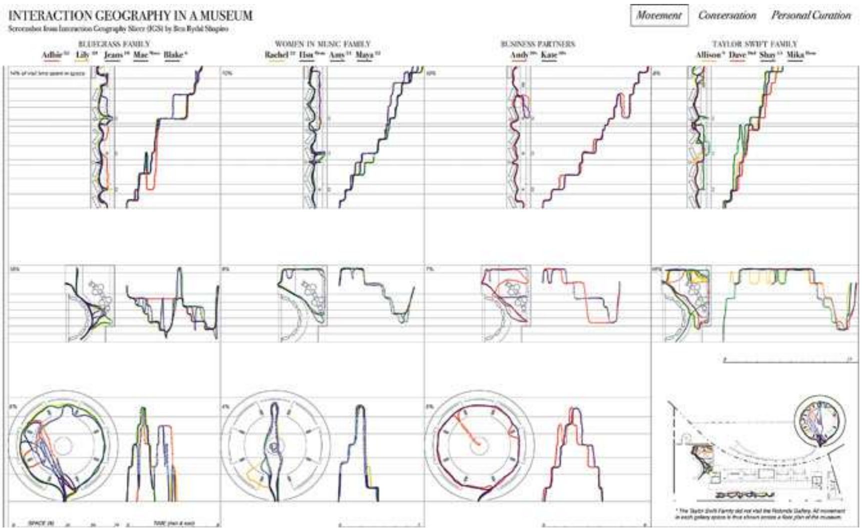

Fig. 3 Screenshot from IGS showing movement of 4 visitor groups in 3 gallery spaces. Copyright © by Ben Rydal Shapiro. Reprinted by permission

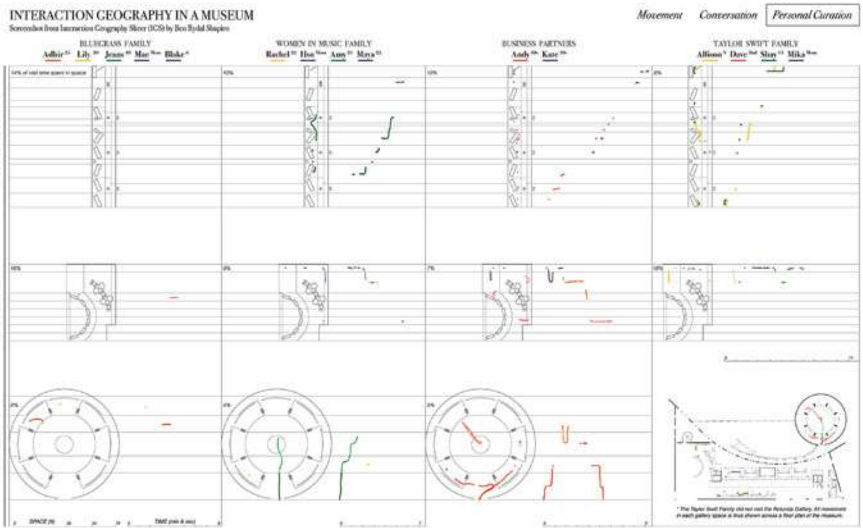

Fig. 4 Screenshot from IGS showing personal curation of 4 visitor groups in 3 gallery spaces. Copyright © by Ben Rydal Shapiro. Reprinted by permission

personal information devices and/or social media to collect, edit, and/or share content from the museum. Columns in each figure distinguish each visitor group/family while rows indicate different gallery spaces. All displayed information across these figures is set to the same scales. Since the "Taylor Swift Family" did not visit the Rotunda Gallery, all visitor groups' movement and personal curation is combined on a larger floor plan drawing of the entire museum.

Figures 3 and 4 illustrate the comparative possibilities of interaction geography. In this setting these comparative possibilities support studying how individual visitors and groups of visitors align with cultural heritage content. For instance, it is clear (for those who know these spaces such as museum professionals working at this museum) that the "Women in Music Family" (2nd column) interacts in a variety of ways with exhibits and gallery spaces that feature female artists while the Bluegrass Family (1st column) exhibits very different types of interactions around exhibits that feature early Country and Bluegrass artists. Likewise, these figures can be used to identify heightened moments of potential interest and engagement (e.g. young children's rapid/sharp movements in space-time). Using the IGS in this setting, these moments can be unpacked to understand, for example both how parents structure young children's conversation to learn (the primary focus of learning research in museums) and also how young children use their families as interpretive resources for learning through their expressive movements and conversations. For example, closer analysis of Blake's movement and conversation in the space-time view during minutes 3–5 while visiting the Rotunda gallery (column 1 and row 3) illustrates how, Blake first failed to get an answer to a question he posed to Adhir as to who co-starred in the 1970s action/comedy film Smokey and the Bandit. Immediately afterward, Blake ran to another gallery space to find and get the correct answer from his brother Jeans. Subsequently, Blake then raced back to re-join Adhir in the Rotunda Gallery in order to inform Adhir that it was Jerry Reed, a Grammy-winner country artist, that co-starred in the film.

Extending Physical Learning Space Evaluation

From Static Representations to Interactive Visualisations. The previous figures illustrate how interaction geography uses Mondrian Transcription to integrate representations from a variety of disciplines. These representations include floor plans, transcripts of conversation, and personal time geography (Hagerstrand, 1970). As a result, new types of multi-scalar analyses are possible that link detailed analyses of people's interaction at locations in the physical environment with analyses of people's interaction as they move across the physical environment.

The previous figures and analysis also provide a glimpse of how the IGS supports dynamic interaction with these representations. For example, in this case, analysis of the previous figures begins to convey how the IGS allows researchers and practitioners (e.g. museum professionals) to select sequences of movement and conversation for closer analysis, to watch audio and video from the perspective of each family member, and to re-scale space or time in order to study phenomena at different scales while conducting new types of comparative analysis.

Historically, representations used to evaluate physical learning spaces have been static (i.e. providing snapshots of space) and often unidimensional (i.e. only focusing on space and not people's interaction or movement over space and time). Interaction geography illustrates the potential and new possibilities to use dynamic visualisations as opposed to static representations in order to evaluate physical learning spaces.

Incorporating Broader Views of Learning. Current approaches to the evaluation of physical learning spaces typically operate from a positivist stance. For example, in an informal setting such as a museum, such a stance dictates both a model of a museum visitor as a relatively passive consumer of intended exhibit design as well as evaluation methods that focus on how physical structures of gallery spaces support visitors' acquisition of the intended design and narrative of exhibits produced by museum curators and designers. Such a stance provides valuable information to inform future design. However, such a stance often ignores people's activity and how people produce and pursue their own learning in ways that are very different from how people acquire intended design/curricula.

Interaction geography provides concepts and methods to describe people's interaction (e.g. pace of talk or movement, social media use) at a scale that maintains a focus on the physical design of space. In the figures above, one result is the ability to characterise Blake's efforts to lead Adhir on a tour. This characterisation provides one vivid example of how children's seemingly erratic movement patterns, which current evaluation methods might either miss entirely or suggest detract from Blake's and his family's ability to acquire knowledge about exhibits, reflect Blake's very intentional efforts to pursue his own interest-driven learning: In this case by teaching other family members about the cultural heritage content of a museum gallery space. More generally, interaction geography provides a means to study how people's activity responds to the physical design of spaces (and changes made to these spaces) over varying periods of time (e.g. potentially over hours, days, and longer periods of time). Studying changes in activity or participation is central to theories of learning that study how learning is distributed across people, tools, and physical learning environments (Cole, 1996; Gutiérrez, Morales, & Martinez, 2009; Vygotsky, 1980) and how people learn through participation in socially and culturally organised practices of a community (Lave & Wenger, 1991). Put differently, interaction geography supports evaluating physical learning spaces not only with respect to how they may influence learners' performance on standardised tests or behaviour performance scores but also with respect to how they support or do not support social contexts for learning.

Incorporating broader theories of learning into the evaluation of physical learning spaces encourages new research that may be necessary to illustrate how and why there appears to be a relation between the physical design of space and learning. For example, in classroom and school settings, such work might include assessing how physical space shapes the embodied production of identity (Leander, 2002) or structures joint participation in specific disciplinary practices such as writing (Rowe, 2008) or how physical proximity influences teachers' interactions with peers about teaching (Spillane, Shirrel, & Sweet, 2017). Alternatively, in natural or urban environments such work might include studying how people's personal mobility is both the means and content for learning or describing how people "make places" to pursue their own interest-driven learning as they move through physical spaces rich with meaning potential (Hall, Taylor, & Marin, 2017; Marin, 2013).

Evaluating the Alignment of Space and Pedagogy. As mentioned previously, interaction geography describes people's interaction at a scale that maintains a focus on the physical design of space. As a result, it supports studying the alignment between space and pedagogy in new ways (Cleveland & Fisher, 2014). For example, consider the application of interaction geography in classroom settings to ask and answer questions about the physical design of learning spaces that are challenging to address with current methodological approaches. These questions include: How do teachers use or not use particular areas of space over single or multiple lessons? When and where do students have access to particular types of instruction or pedagogical interactions? How does students' and teachers' movement and conversation reveal types of empowering and disempowering pedagogies that are built into the physical design of certain classrooms (Monahan, 2002, 2005; Cleveland, 2009).

Furthermore, current research emphasises that evaluating the alignment of space and pedagogy necessitates close collaboration between researchers and professional practitioners (e.g. teachers, museum professionals) working in the spaces being studied. Interaction geography provides a highly visual method that may support this collaboration in ways that can inform future design. For example, the previous figures were utilised in collaboration with museum professionals at one particular museum.

Making visitor interaction and personal curation visible for these professionals had a significant impact on this museum. In particular, studying the previous figures contributed to the redesign of one museum gallery space and supported challenging interdepartmental and crossdisciplinary conversations between museum curators, educators, and architects who held very different beliefs as to what makes a successful gallery space. Likewise, prior to viewing these visualisations, museum professionals at this museum did not realise visitors used social media while in their gallery spaces and thus, had not developed educational programming or marketing initiatives that encouraged or supported visitor's personal curation. In response to these visualisations, this museum developed social media policies (e.g. hashtag/indexing mechanisms) that encouraged the use of personal curation to learn and teach others about museum content in ways that also advanced the museums' marketing and educational goals. More recently, this museum has begun to explore more personalised ways to support visitors' personal curation, for example, by supporting teachers to use museum content to develop their online teaching profiles (see Shapiro & Hall, 2018).

Limitations and Next Steps

In summary, this chapter reviewed and explored how interaction geography, a new approach to describe, represent and interpret people's interaction over space and time, extends current approaches to the evaluation of physical learning spaces. This chapter concludes by discussing some of the primary limitations in this early work that must be addressed to expand the use of interaction geography to evaluate physical learning spaces.

First, as demonstrated in this chapter, reading visualisations produced by interaction geography is challenging and necessitates new types of interdisciplinary thinking as well as close collaboration with practitioners who are in the best position to interpret these visualisations. Future research will need to explore a variety of questions related to this challenge. For instance, these questions include: What resources do different disciplines and practitioners working in different disciplines offer to read representations of interaction geography? What insights do different disciplines and these practitioners offer to interpret these representations from a learning perspective? Using Blake's tour as a starting point, what is a taxonomy of interaction geography patterns that can be read to study productive or unproductive alignments between space and pedagogy in different types of physical learning spaces?

Second, questions regarding how to generalise methods of interaction geography in an ethically informed manner are only beginning to be explored. For example, recent work has applied the IGS to visualise and discuss New York City's controversial Stop-And-Frisk Program (Shapiro & Pearman 2017). However, future research will need to explore a variety of questions that necessitate further technical/computational development of the methods/software illustrated in this chapter. These questions include: How can researchers, designers, and practitioners working in a variety of settings customise and use these methods to evaluate physical learning spaces? What types of visual analytics and natural language processing need to be incorporated into the IGS to advance its utility? What settings and institutional contexts are these methods ethically and not ethically appropriate?

Third, interaction geography is a very new approach that is only beginning to be applied beyond the museum setting described in this chapter. Future research will need to test and assess the usefulness of interaction geography in a variety of settings. In particular, future research will need to conduct research to develop comparative questions and analyses. For example, future research needs to explore questions such as what are productive spatial and temporal scales or boundaries of settings that enable comparative work based on interaction geography? What types of mappings (e.g. of people, artefacts, sound) does interaction geography support? What types of physical spaces is interaction geography best (and least) suited?

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References

Blackmore, J., Bateman, D., Loughlin, J., O'Mara, J., & Aranda, G. (2011). *Research into the connection between built learning spaces and student outcomes* (Literature Review No. 22). Melbourne: Victorian Department of Education and Early Childhood Development.

Cleveland, B. (2009). Equitable pedagogical spaces: Teaching and learning environments that support personalisation of the learning experience. *Critical and Creative Thinking: The Australasian Journal of Philosophy in Education, 17*(2), 59–76.

Cleveland, B., & Fisher, K. (2014). The evaluation of physical learning environments: A critical review of the literature. *Learning Environments Research, 17*(1), 1–28. https://doi.org/10.1007/s10984-013-9149-3.

Cole, M. (1996). *Cultural psychology: A once and future discipline.* Cambridge, MA: Belknap Press of Harvard University Press.

Ellis, R. A., & Goodyear, P. (2018). *Spaces of teaching and learning: Integrating perspectives on Research and Practice.* Singapore: Springer.

Erickson, F. (2004). *Talk and social theory: Ecologies of speaking and listening in everyday life.* Blackwell Publishing.

Gutiérrez, K., Morales, P. Z., & Martinez, D. C. (2009). Remediating literacy: Culture, difference, and learning for students from nondominant communities. *Review of Research in Education, 33*, 212–245.

Hagerstrand, T. (1970). What about people in regional science? *Papers in Regional Science, 24*(1), 7–24. https://doi.org/10.1111/j.1435-5597.1970.tb01464.x.

Hall, R., Taylor, K. H., & Marin, A., with Support of the National Science Foundation and Vanderbilt University. (2017). *Building Capacity for New Genre of Learning on the Move (LoM).* Retrieved February 10, 2018, from https://www.lom-meshworking.org.

Hillier, B. (2008). Space and spatiality: What the built environment needs from social theory. *Building Research & Information, 36*(3), 216–230. https://doi.org/10.1080/09613210801928073.

Imms, W., & Byers, T. (2017). Impact of Classroom design on teacher pedagogy and student engagement and performance in mathematics. *Learning Environments Research, 20*(1), 139–152. https://doi.org/10.1007/s10984-016-9210-0.
Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* New York: Cambridge University Press.
Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *The Journal of the Learning Sciences, 4*(1), 39–103. https://doi.org/10.1207/s15327809jls0401_2.
Kendon, A. (1990). Spatial organization in social encounters: The F-formation system. *Conducting Interaction: Patterns of Behavior in Focused Encounters*, 209–238
Leander, K. (2002). Locating Latanya: The situated production of identity artifacts in classroom interaction. *Research in the Teaching of English, 37*(2), 198–250.
Marin, A. M. (2013). Learning to Attend and Observe: Parent-child Meaning Making in the *Natural World.* Ph.D. dissertation. Northwestern University.
Monahan, T. (2002). Flexible space and built pedagogy: Emerging IT embodiments. *Inventio, 4*(1), 1–19.
Monahan, T. (2005). *Globalization, technological change, and public education.* New York: Routledge.
Peponis, J. (2005). Formulation. *The Journal of Architecture, 10*(2), 119–133.
Rowe, D. (2008). The social construction of intentionality: Two-year-olds' and adults' participation at a preschool writing center. *Research in the Teaching of English, 42*(4), 387–434.
Shapiro, B. R., Hall, R., & Owens, D. (2017). Developing & using interaction geography in a museum. *International Journal of Computer-Supported Collaborative Learning, 12*(4), 377–399. https://doi.org/10.1007/s11412-017-9264-8.
Shapiro, B. R., & Hall, R. (2018). Personal curation in a museum. In *Proceedings of the 2018 ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '18).* New York, NY, USA: ACM.
Shapiro, B. R., & Pearman, F. A. (2017). Using the interaction geography slicer to visualize new york city stop & frisk. In *Proceedings of the IEEE VIS 2017 Arts Program, VISAP '17*. Phoenix, AZ. https://doi.org/10.1109/visap.2017.8282370.
Spillane, J. P., Shirrell, M., & Sweet, T. M. (2017). The elephant in the schoolhouse: The role of propinquity in school staff interactions about teaching. *Sociology of Education, 90,* 149–171. https://doi.org/10.1177/0038040717696151.
Tanner, K. C. (2009). Effects of school design on student outcomes. *Journal of Educational Administration, 47*(3), 381–399. https://doi.org/10.1108/09578230910955809.
Taylor, K. H., & Hall, R. (2013). Counter-Mapping the neighborhood on bicycles: Mobilizing youth to reimagine the city. *Technology, Knowledge and Learning, 18*(1–2), 65–93. https://doi.org/10.1007/s10758-013-9201-5.
Tufte, E. R. (1990). *Envisioning information.* Cheshire, Connecticut: Graphics Press.
Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes.* Harvard University Press.
Wineman, J., Peponis, J., & Dalton, R. (2006). Exploring, Engaging, Understanding in Museums. Paper presented at the Space Syntax and Spatial Cognition Workshop: Spatial Cognition '06, Universität Bremen, Bremen.
Zimring, C. M., & Reizenstein, J. E. (1980). Post-occupancy evaluation: An overview. *Environment and Behavior, 12,* 429–450. https://doi.org/10.1177/0013916580124002.
Zimmerman, A., & Martin, M. (2001). Post-occupancy evaluation: Benefits and barriers. *Building Research & Information, 29,* 168–174.

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Measurement

Introduction to Part III: Measurement

Wesley Imms and Kenn Fisher

Abstract 'Measurement' of the impact of learning environments has occurred for quite a long time, but its role in driving and guiding reforms in ILE design and use has not been as effective. This is due to a lack of common terminologies, too wide a scope of what constitutes 'learning environments' and too often the use of very poor methods. This section presents a number of evaluation initiatives, playing a part in exploring new approaches to 'good' evaluation.

Not enough has been said about the paucity of solid evidence needed to inform ILE development. LEaRNs many projects have helped a small international band of researchers highlight the perilous state of research conducted to date, and within ILETC it has focused specifically on what is known and needs to be known in terms of ILE impact on student learning outcomes (Byers, Mahat, Liu, Knock, & Imms 2018), teacher use of space (Bradbeer, Mahat, Byers, & Imms 2019), and student deeper learning. A critical argument has been the need to build an evidence base that breaks the cycle of fads and bandwagons that have plagued ILE development since the 1960s (Imms, 2018). But this message must be followed by action—the active pursuit of robust evidence that shows where ILEs succeed and where they fail—and why this happens.

ILETC is an example of that work, but still more remains to be done to provide a substantive causative link between pedagogy and space. This package of chapters considers how the materiality of the built form provides effective affordances to support the activities therein. Reading between the lines, we also see how much work of this ilk is required; grand statements about success have limited usefulness, whereas the small projects described here constitute the fabled research 'bricks in the wall', which over time cumulatively create the robust knowledge base we need.

Byers used an observational metric to track the practices of over 20 secondary science, mathematics, and engineering teachers in a variety of spaces. His focus was on mapping and identifying practices, perceptions of student learning, and correlating

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these to qualities of the various built environments in which those practices occurred. This logical, replicable, analytical approach allowed him to identify trends in practices consistent with various learning space types. While Byers' earlier work isolated learning space types as variables when assessing impact on learning outcomes (Byers, Imms, & Hartnell-Young, 2018), the more sophisticated study presented here tackled the often-ephemeral phenomenon of teachers' actual practices. As a study, it identified useful concepts that are likely even by now to be superseded by newer thinking, but the core message in this chapter is of designing robust ways of capturing data to build foundational knowledge.

A collaborative Danish research team—Imke Wies van Mil, Olga Popovic Larsen, Karina Mose and Anne Iversen—takes an innovative look at how lighting affects behaviour in non-school spaces to then leverage this into informing school design. The team moves outside the school sector to see developments around lighting and how they may be re-purposed into school design, which is a very worthwhile and under-researched exercise. We all understand the use of lighting, for example highlighting heritage buildings in the evenings, focus lighting for restaurant table settings, and even disco lighting to take an extreme viewpoint. What the authors focus on is the contrast between light and dark and shades between that lighting can be offered in built environments. They argue that architects should focus as much on artificial lighting as they do on natural lighting, a concept highly evolved in Scandinavia countries. If design for health and well-being (Hughes, Franz & Willis, 2019) is explored, then it makes eminent sense to curate a variety of learning settings for a variety of activities to support a variety of differentiated teaching. The team compared six different learning environments to evaluate the cognitive impact of the different lighting arrangements. Teaching staff were invited to review the results with a distinct preference emerging for a particular lighting arrangement. This approach offers significant opportunities for 'precision' school design as innovative learning environments evolve (in adapting the emerging 'precision medicine' dialogue).

Ji Yu explores potential links between the learning environment and student learning outcomes through the lens of Chinese learners. She differentiates 'surface' approaches to learning and 'deep' approaches to learning in comparing various taxonomies across the three factors: cognitive processing activities, affective or motivational learning activities, and (self-) regulative activities. Ji Yu notes that Chinese students tend to focus on combining memorising with understanding, although in Hong Kong some Western approaches are gaining traction. Generalisation is difficult given the 56 ethnic groups and disparate educational systems across the country. Four themes emerged from the study of two contrasting learning environments with two contrasting pedagogies: learning space and students' conceptions of learning, learning space and cognitive aspects of learning, learning space and affective aspects of learning and, finally, the learning space and the (self-) regulative aspects of learning. Ji asserts that space can shape learner behaviour and particularly singles out the contrast between instructor led (formal) and self-directed (informal) student behaviours. To this could be added the social aspects of learning completing a triad of learning (spatial) modalities (Fisher, 2003).

Jane Zhang compares the creative process in learning through a dual approach of ‘flaring’ and ‘focusing’. Focusing is the notion of concentrating on a specific subject or task, whereas flaring is adapting the knowledge gained to problem-solving. At one extreme, applied to kindergarten at MIT, there are four factors which may support creative learning: projects, peers, passion, and play.[1] In studying at Harvard—and moving to the alternate end of the learner age spectrum—Zhang is able to engage in case studies with two learner typologies: one at the Harvard Graduate School of Design and the other being the Harvard Innovation Lab. The former uses a design studio-based pedagogy having its origins in the Bauhaus, while the latter has a variety of spaces to support incubators and student-led start-up projects in a cross-faculty manner similar to MIT’s D-Lab. Students completed online questionnaires to support observational studies. The findings reinforced the idea of alternately focusing (narrowing) and flaring (or broadening). In some respects, this resonates with Nonaka’s (1998) modes of knowledge construction and management, although these iterate across four developmental activities—internalisation, socialisation, externalisation, and finally, combination. Zhang’s creative learning spiral—with the quadrants of ‘sparking’, ‘making’, ‘grazing’, and ‘socialising’ across four associated domains of focus, flare, objects, and people—is an interesting and innovative ‘take’ on Nonaka’s. Above all, Zhang found a strong correlation between pedagogy/activity and space/affordance in the two examples.

One cannot underestimate the importance on the type of material created and presented in this Section. Often considered ‘too hard’ to collect, with the mass of confounding variables that characterise the use of ILEs, ILETC, and Transitions conferences have steadfastly pulled together a range of quality researchers who are meeting this challenge. To reiterate, this Section highlights the diversity and scope of issues to be addressed if we are to ever confidently say we have a solid understanding of what works, when, and why.

References

Bradbeer, C., Mahat, M., Byers, T., & Imms, W. (2019). *A systematic review of the effects of innovative learning environments on teacher mind frames.* Melbourne: University of Melbourne. Retrieved from http://www.iletc.com.au/publications/reports.

Byers, T., Mahat, M., Liu, K., Knock, A., & Imms, W. (2018). *Systematic review of the effects of learning environments on student learning outcomes.* Melbourne, Australia: University of Melbourne. Retrieved from http://www.iletc.com.au/publications/reports.

Byers, T., Imms, W., & Hartnell-Young, E. (2018b). Comparative analysis of the impact of traditional versus innovative learning environment on student attitudes and learning outcomes. *Studies in Educational Evaluation, 58,* 167–177. https://doi.org/10.1016/j.stueduc.2018.07.003.

Fisher, K. (2003). Designs for learning in the knowledge age. *PEB Exchange, Programme on Educational Building, 2003/13.* OECD Publishing https://doi.org/10.1787/656483245788.

[1]Sign on local primary school street display board: play is the highest form of research: Einstein. https://www.earlylearninghq.org.uk/latest-resources/inspirational-quotations-albert-einstein/ Are.

Hughes, H., Franz, J. & Wills, J. (2019) School spaces for student wellbeing and learning: Insights from research and practice. Singapore: Springer.
Imms, W. (2018). Innovative learning spaces: Catalysts/agents for change, or 'just another fad'? In S. Alterator & C. Deed (Eds.), *School space and its occupation: The conceptualisation and evaluation of new generation learning spaces* (pp. 107–118). Amsterdam, The Netherlands: Sense Publishing.
Lefebvre, H. (1991). The production of space. Blackwell Publishing, Oxford.
Monahan, T. (2002). Flexible space & built pedagogy: Emerging IT embodiments. *Inventio, 4*(1), 1–19.
Nonaka, I. & Konno, N. (1998). The concept of "ba": Building a foundation for knowledge creation. *California Management Review; Spring 1998, 40*(3), ABI/INFORM Global 40.

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What Does Teaching and Learning Look like in a Variety of Classroom Spatial Environments?

Terry Byers

Abstract The very nature of what constitutes an effective learning environment is undergoing substantial re-imagination. Authors have suggested that the affordances of existing learning spaces, often termed conventional or traditional classrooms, is limited and constrains the possible pedagogies available to teachers. Architects, authors and governments have put forward innovative learning environments (ILEs) as a better alternative. ILEs provide affordances thought to be somewhat better at providing to students learning needs than traditional classrooms, particularly in terms of creative and critical thinking, and collaborative and communicative workers. However, there is little evidence available to show of either spatial type (traditional classroom or ILE) performs pedagogically to either hinder or support the desired approach/es to teaching and learning being sought by current educational policies. One could suggest that a populistic narrative often drives the growing investment in new school learning spaces, facilitated by a vacuum of credible evidence of their impact. This paper will report findings from a three-year study that tracked the practices over time of secondary school Engineering, Mathematics and Science teachers ($n = 23$) as they occupied two quite dissimilar spatial layouts. The *Linking Pedagogy, Technology, and Space* (LPTS) observational metric, with its provision of instantaneous quantitative visual analysis, was used to track their practice, and student learning, in a variety of spatial layouts. Subsequent analysis identified broad trends within the data to identify those factors, spatial, subject or confounding teacher factors, which influenced student and teacher activities and behaviours. Importantly, it presented new evidence that works against the current, overt focus on contemporary spatial design. It suggests that greater emphasis on unpacking, and then developing, the mediating influence of teacher spatial competency (how, when and why one uses the given affordances of space for pedagogical gain) is required for any space to performance pedagogically.

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Introduction

The critical drivers of digital technology, neoliberal policy and the subsequent drive for quality teaching and learning, have led some to question the efficacy of conventional or traditional classrooms (Benade, 2016; Dovey & Fisher, 2014). Such a reconsideration stems from the emergent view that their 'built pedagogy' (Monahan, 2002) is somewhat constrained and favours more teacher-led and didactic instruction (Fisher, 2006; Tanner, 2008; Upitis, 2004). Dovey and Fisher (2014) surmise that this inhibits the ability of teachers to enact a broader spectrum of pedagogies as dictated by policies, which favour a higher incidence of student-centric and technology-enhanced learning.

This appraisal of existing designs has led to experimentation with more contemporary spatial models, often referred to as innovative learning environments (ILEs). The Organisation for Economic Cooperation and Development (OECD) describe ILEs as multi-modal, technology-infused and flexible learning spaces that are responsive to evolving educational practices (OECD, 2013). ILEs intend to provide those affordances and support a view of learning that is thought to be somewhat better than a traditional classroom (Benade, 2016). However, recent reviews found few evaluative approaches (Painter et al., 2013), hence little empirical evidence (Blackmore, Bateman, O'Mara, & Loughlin, 2011), that indicates how ILEs, or in fact traditional classrooms, perform pedagogically (Byers, Imms, Mahat, Liu, & Knock, 2018; Gislason, 2010).

A three-year-longitudinal observational study followed teachers in their occupation of different spatial layouts in a secondary school—in Australia this comprises students from approximately 13–18 years of age. This paper will report on a comparative analysis of teachers ($n = 23$) from the 'conceptually similar' subjects of Engineering, Mathematics and Science. Repeated measures obtained using the *Linking Pedagogy, Technology, and Space* (LPTS) observational metric (Byers, 2017), presented quantitative data in the form of 'timed' student and teacher activity and behaviour. Subsequent visual analysis evaluated those factors, spatial or other, that could be interpreted as influencing the pedagogical performance of the differing learning environment being used by these teachers over time. Importantly, this study illuminated how teachers from the same subject areas taught in a range of spatial environments. It identified the previously theorised concept of spatial competency (by Lackney, 2008; Leighton, 2017; Steele, 1973) to explain how teachers worked with and used (or not) the various affordances of the given learning environment for pedagogical gain; or indeed if they were agonistic in their use.

The Study

This longitudinal study of Engineering, Mathematics and Science teachers and their students took place in an independent (private) secondary school in the state of Queensland, Australia. It explored the belief that different spaces are 'agents for change' that lead to changed practice (Oblinger, 2006). As Mulcahy, Cleveland, and Aberton (2015) suggested 'how [and if] these changes take effect … remains an open question [with] little educational research' existing on the impact of traditional or ILEs (p. 576). Such a statement is concerning, given the growing financial and human investment in school learning spaces. It is argued that contemporary learning narratives (such as the current twenty-first-century learning or skills discourse) and personal ideologies (architectural, academic and school leader) underpin the interest and investment in school spaces; despite the lack of empirical evidence articulating their pedagogical value. Many (Brooks, 2011; Byers, Imms, Mahat, et al., 2018; Painter et al., 2013) lament a lack of rigorous methodologies and methods capable of isolating the impact of different spaces on teaching and learning, while accounting for the spuriousness effect/s of the confounding variables at play in the educational setting.

To evaluate the impact of different spatial layouts, ascertained by the typology established by Dovey and Fisher (2014), what was of interest to this study was:

(1) How do different spatial layouts affect teacher behaviour and the pedagogies they employed?
(2) How do the various spatial types affect students' learning experiences?

- Earlier quasi-experimental studies at this site (see Byers, Hartnell-Young, & Imms, 2018; Byers & Imms, 2014, 2016; Byers, Imms, & Hartnell-Young, 2014, 2018a, 2018b; Imms & Byers, 2016) explored the impact of traditional classroom layouts and ILEs on teaching and learning. Findings linked the occupation of different spaces with statistically significant changes in student perceptions in the utilisation of technology, the incidence of more active and responsive learning experiences, and enhanced behavioural and cognitive engagement. The transition from traditional classrooms to spaces, encapsulating the intent of an ILE, noted changes to pedagogies and student engagement that were correlated with 'medium' within-group hedges (*g*) effect size (due to a class as the unit of analysis) calculations (see Table 1). Furthermore, these iterative studies yielded similar Hierarchical Linear Modelling (HLM) findings of Tanner (2008). The HLM in various studies returned an averaged 7% variance in achievement attributed to the different learning environments (while controlling the confounding variables of student IQ, class composition and the teacher).

Even though these studies presented quantitative data that described to some degree the impact of different spaces on student learning, they also highlighted the importance of the mediating influence of teachers' spatial competencies (Lackney, 2008; Leighton, 2017). These studies identified a general correlation in enhanced learning experiences and engagement that led to higher academic results, but the relationship was not causal. These quasi-experimental studies were not able to discern or isolate the underlying, or micro, changes that affected their impact. Some teachers

Table 1 Summary of within-group effect size (*g*) calculations evaluating the pre- and post-spatial intervention on academic achievement across multiple studies

Subject	Number of studies	Study design	School year (age range)	Effect size (*g*) value
English	2	A/B*	7–9 (11–14 years)	0.40 and 0.46
Mathematics	2	A/B	7–9 (11–14 years)	0.41 and 0.86
Humanities	1	A/B	7–9 (11–14 years)	0.30
Technology studies	1	A/B/C**	11–12 (16–18 years)	0.14
Drama	1	A/B/C	11–12 (16–18 years)	0.61
Film, TV and Media	1	A/B/C	11–12 (16–18 years)	0.86
Visual art	1	A/B/C	11–12 (16–18 years)	0.34
Engineering	1	A/B/C	11–12 (16–18 years)	0.21

Note *A/B: Traditional classroom (Baseline)/ILE (Intervention)
Note **A/B/C: Traditional classroom (Baseline)/ILE (Intervention 1)/ILE + Time (Intervention 2)

affected (but were not sure how, when and why) a discernible change in their practice when they occupied a different spatial layout, and this correlated to significant improvement in academic outcomes. On the other hand, some teachers' pedagogies and practices remained largely unaffected, and therefore the change in space had a minimal impact on academic results.

Blackmore et al. (2011), Gislason (2010) and Tanner (2008) found few studies that evaluated how the occupation of different learning environments influenced the nuances of teacher practice and the resulting impact on student learning. The earlier work of Byers et al., (2018b) is an example of an exception to this trend. It presented data through the quantitative analysis of repeated observations of a cohort of teachers prior to, on initial occupation, and then during longer-term inhabitation of an ILE. It described how teachers initially altered and further refined their practice to take advantage (or not) of the postulated affordances of an ILE, as well as documenting those instances of no such change. It further highlighted the mediating role of teacher spatial competency. Spatial competency explains how some teachers, due to their beliefs and pedagogical and discipline knowledge, were more able to articulate how, when and why their practice changed or remained the same when placed in a different physical learning environment (Lackney, 2008; Leighton, 2017; Steele, 1973).

The Context

Since 2010, the site school has engaged in a strategic initiative to better understand the impact of different spaces on teaching and learning. Even though the school had engaged in an iterative process of low-cost refurbishments, the vast majority of classrooms were typical of traditional classrooms that Dovey and Fisher (2014) described as Type A spaces (Fig. 1).

As is illustrated in Fig. 2, all were conventional cellular spaces accessed by a corridor or veranda. The layout of chairs and desk were set in rows or groups facing the 'fireplace' teaching position at the front of the classroom (Reynard, 2009). Even though all Mathematics classes at the school were timetabled in Type A spaces, a significant proportion of the teachers within this sample participated in the earlier spatial interventions at the school. As a result, it was assumed that the spatial competency of the Mathematics sample was more developed than that of their peers.

The second group of spaces were cellular Science laboratories accessed by a substantial Learning Commons (Fig. 3). These spaces best match those spaces that Dovey and Fisher (2014) identified as Type B spaces. These laboratories had large, fixed benches focused upon the front demonstration/teaching position, similar to the Type A spaces. Additional fixed practical areas (standing height benches with gas

Fig. 1 Typology of spatial design (*Source* Imms, Mahat, Byers, & Murphy (2017). Reprinted with permission from the ILETC Project)

Fig. 2 Traditional classroom (Type A) mathematics classroom

and water) were situated around the periphery of each lab. However, they differed from other Type A spaces by a large exterior Learning Commons, which contained seating and large display areas.

The final spatial type evaluated in the study was the retrofitted Creative Precinct (Fig. 4). The Precinct merged two existing buildings into a single pedagogical space. The Precinct housed the Creative Arts (Drama, Film, TV and New Media, and Visual Art) and Design and Technology (Engineering and Technology Studies) Faculties. The open-studio design throughout, which best epitomises a Type D space, afforded the opportunity for teachers and students to occupy and transition between various external and internal spaces.

Method

Over a three-year period, more than 200 observations were conducted using the LPTS observational metric. However, this study, it will report on 91 observations across the subjects of Engineering, Mathematics and Science.

The macro-enabled Microsoft Excel LPTS metric, used by a trained observer, times student and teacher activity and produces a real-time visual breakdown across

Fig. 3 Science laboratory (Type B)

Fig. 4 Engineering space in the *Creative Precinct* (Type D)

five domains (pedagogy, learning experiences, communities of learning, and student and teacher use of technology). The macro-enabled Microsoft Excel platform utilises a series of stopwatches to time student and teacher activity and behaviours across five domains (pedagogy, learning experiences, communities of learning, and student and teacher use of technology).

It can simultaneously log how long teachers engage in didactic instruction, such as a lecture, or when they encourage whole-class discussion, or question individuals or the entire class. This is done through a single observer interface. The interface allows a single observer to check the box that corresponds to an observed activity, which starts and then stops associated stopwatch timer. The macro-enabled programme then combines each observed instance of the activity, producing a cumulative time for each activity. The design of the metric produces an instantaneous visual breakdown for each observation that can then be easily shared with the teacher.

Pilot-testing during the earlier (Byers et al., 2018b) study demonstrated adequate interrater reliability, with Chi-square frequencies of the observations of six teachers by three observers across a total of twelve occasions not being statistically different ($p > 0.05$) (Bielefeldt, 2012). The use of time as the means to record activity, unlike traditional observational notes, also reduced the influence of observer inference. Furthermore, the application through a time-series design established controls of confounding variables (i.e. teaching and learning cycle and time of day) by the quasi-experimental design.

Repeated measures observational data for each participant (at a minimum of three observations) were completed by the same observer. The resulting data was averaged first, to produce a 'typical' lesson for that teacher. Next, the visual analysis identified general trends across the three spatial types. Multivariate visual and nonparametric analysis to identify statistically significant differences in activities and behaviour between teachers, subjects and spatial types, will be the subject of future publications.

Results and Discussion

Teacher Behaviour and Pedagogies

The pedagogy domain of the LPTS metric included the attributes of: didactic instruction, interactive instruction, facilitation, providing feedback, class discussion and questioning. The visual analysis identified notable pedagogical differences between the subjects that were considered to be somewhat 'conceptually similar' (Fig. 5). Typically, teachers in this sample displayed a pedagogical approach best aligned with a variant of teacher-guided (or fully guided) explicit instruction (see Kirschner, Sweller, & Clark, 2006; Rosenshine, 1987). These subjects favour systematic and well-defined content, and procedural knowledge, which Rosenshine (1987, 2012) found is best (when compared to purely constructivist methods) taught through explicit instruction. Furthermore, explicit instruction bests support novices (students)

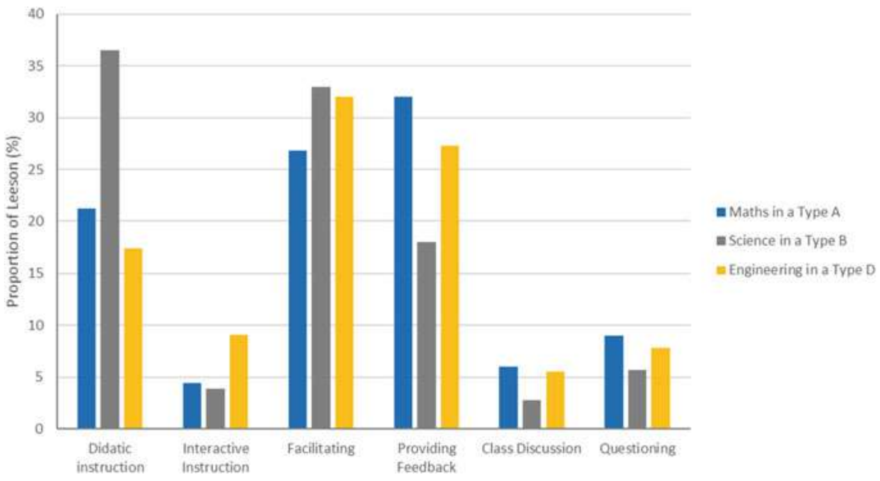

Fig. 5 Proportional breakdown of teacher pedagogies in mathematics in Type A ($n = 31$), science in Type B ($n = 29$) and engineering in Type D ($n = 31$) spaces

to acquire, consolidate and encode the requisite surface knowledge for deeper learning/thinking without overwhelming their working memory, or 'cognitive load' (Hattie & Donoghue, 2016; Kirschner et al., 2006).

Instruction (Didactic/Interactive) was observed in the initial stages of most lessons. The Science teachers in Type B spaces, which were the most rigid (due to the fixed student and teacher benches), mostly instructed from the traditional front of the space, for approximately 40% of a lesson, utilising a teacher-centred modality (Fig. 5). Here the built pedagogy of these spaces made it easier for teachers to engage in teacher-led and didactic instruction (Reynard, 2009). The rigidity of the space made any other pedagogical approach virtually impossible. As a result, this presents a concrete example of how the built pedagogy of a space overtly dictated teacher pedagogical practice. The rigidity of the fixed setting actively restricted the ease for which teacher could easily switch to or engage in other modalities.

The Mathematics teachers in Type A spaces where furniture was not fixed as in Type B labs, spent considerably less time (approximately 15% of lesson duration) instructing from the front-of-room position. Even though the spaces had, by their design, a similarly built implied pedagogy to the Science labs, the incidence of the modality of instruction in Mathematics classes was like that of the Engineering sample (approximately 25% of lesson duration) in the Type D spaces. It is argued that the enhanced spatial competency of the Mathematics sample, developed in previous spatial interventions, somehow supported them to use the given spatial affordances adeptly. Such evidence does push against that the current narrative that traditional classrooms are more likely to support a teacher-led, didactic instruction model than an ILE.

Even though their spatial types differed, the Engineering and Mathematics teachers modelled a pattern of explicit instruction (Rosenshine, 1987). However, the decrease in time spent in a direct instruction mode (approximately 15% of lesson duration) correlated to a higher incidence of Discussion and Questioning. Often, these samples utilised more active and responsive modes to check for student understanding through scaffolded worked examples. These modes supported students to consolidate student understanding from which schemata for deeper learning are built (Hattie & Donoghue, 2016), while reducing their cognitive load (Kirschner et al., 2006). Importantly, this occurred in a traditional and ILE space. As a consequence, one could argue that the ability to complement the necessity of the teacher-led, didactic instruction model with the enhanced responsiveness (i.e. checking for student understanding) class discussion and questioning (Rosenshine, 2012) is not mutually exclusive, nor, restricted to the type of spatial layout.

Following the more teacher-led phase, teachers typically transitioned to some form of applied practice facilitated through 'facilitation' and supported by 'feedback'. The Engineering and Mathematics samples were quite dynamic about the space during this phase of the lesson. Greater movement about the room moderated behaviour and supported the efficient provision of feedback to an individual or small group of students. On the other hand, the Science sample remained for considerable periods of time at the fixed front bench. At times, teachers moved about the periphery of the arranged student benches. However, the rigid and tight arrangement of benches appeared to inhibit student and teacher movement. When feedback occurred, teachers were often at a distance from the students asking for assistance. This limited the teachers' capacity to efficiently assess and monitor student progress, and it seemed to inhibit opportunities for systematic correction and feedback (Rosenshine, 2012).

Learning Experiences

The 'learning experiences' domain of the LPTS metric included the attributes: formative assessment, receive instruction, remember/recall, understand, apply, analyse, evaluate and creation/practical activity. Dovey and Fisher (2014) and Upitis (2004) suggest that a more conventional or traditional classroom space operates at the transmission end of the learning continuum (Receive Instruction and Remember/Recall). The visual analysis of the Type B sample (Fig. 7) would support this suggestion, with students engaged in activities associated with the receipt and recall of surface knowledge. The passive reception of instruction (approximately 43% of each lesson) through a teacher-centric modality of learning was the dominant learning modality (Fig. 6). Progression through the learning cycle was often linear or lock-step, limiting those opportunities for students to actively engage in the consolidation of surface knowledge and deep learning.

The visual analysis of the Engineering and Mathematics samples revealed a greater differentiation of and increase in total student activity when compared to the Science sample. Both achieved this by facilitating different activities within the learning cycle

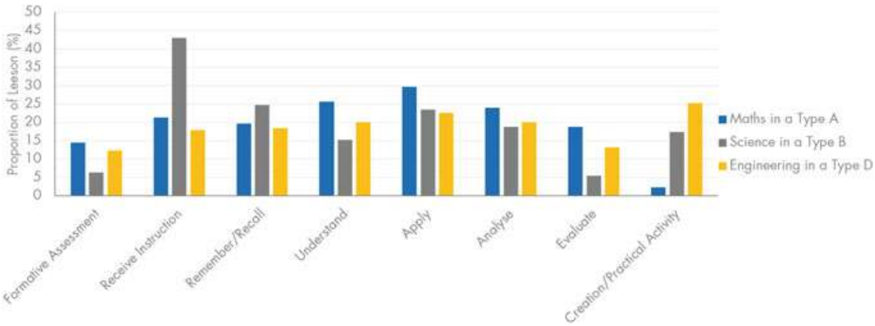

Fig. 6 Proportional breakdown of student learning experiences in mathematics in Type A ($n = 31$), science in Type B ($n = 29$) and engineering in Type D ($n = 31$) spaces

to occur concurrently, through a greater incidence of student-centric and informal learning modalities (Fig. 7). In particular, analysis of the Engineering sample demonstrates their utilisation of the full array spatial affordances, presented by their Type D layout. These teachers successfully utilised the design intent of the open-studio spaces to differentiate the modalities of learning and increased the incidence of practical activity. Not as pronounced, the Mathematics teachers were able to differentiate activities through the movement of students within the cellular space. Both samples actively exploited the available spatial affordances to orchestrate the full spectrum of learning experiences that supported the acquisition and consolidation of surface knowledge (Understanding) to the engagement with deeper learning (Apply, Analyse and Evaluate).

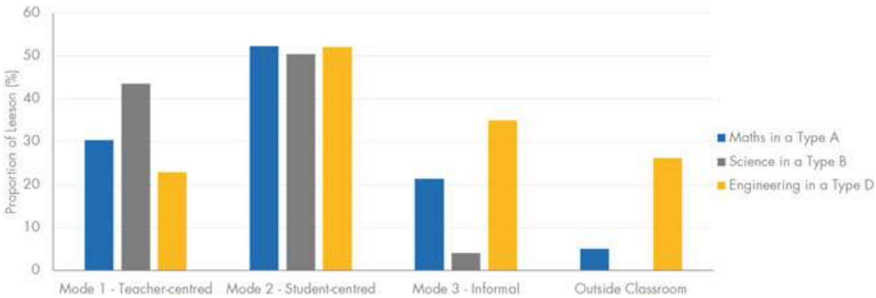

Fig. 7 Proportional breakdown of student occupation of the Fisher (2006) Modalities of learning in mathematics in Type A ($n = 31$), Science in Type B ($n = 29$) and engineering in Type D ($n = 31$) spaces

Conclusion

The current interest in learning environments is often driven by the premise that a change in space will act as a conduit for a desired pedagogical change. However, there exists a dearth of rigorous evaluative methods, thus empirical evidence, to show if the occupation of these different spaces manifests in this envisioned changed. This study attempted to illuminate how different spatial types, traditional (Types A and B) and ILE (Type D), affected both teacher and student activity and behaviour. The longitudinal observation of secondary Engineering, Mathematics and Science teachers through the LPTS observation metric presents initial empirical evidence through a novel evaluative approach.

The analysis found correlations that suggest the different spatial layouts did influence pedagogy, particularly in the comparison of Type B (Science) and Type D (Engineering) spaces. Importantly, it provides initial evidence (through the Mathematics sample) that a more developed spatial competency can allow teachers to utilise the 'limited' affordances (according to the current narrative) of a traditional classroom or Type A space, for pedagogical gain. Such evidence does work against a somewhat populistic, design-centric, narrative that is often espoused during learning space conversations. The data presented in this study suggest the so-called traditional classroom remains pedagogically sound under certain conditions, and greater emphasis needs to be placed on developing teacher spatial competency. This includes knowledge that helps teachers select the correct spatial design to match desired learning outcomes (Imms, 2018). Spatial competency, first coined by both Lackney (2008) and Steele (1973), and further developed by Leighton (2017), underpins a teachers' capacity to navigate and evolve their practices to utilise the affordances of the new spaces for pedagogical gain.

The comparative analysis of repeated observations of teachers from conceptually similar subjects in these three spatial types revealed two key findings. The first relates to how the different spatial types influenced the pedagogy and learning experiences. The analysis of the Science sample in a Type B layout suggested how its built pedagogy, a rigid layout about a teacher-centric, front-of-room orientation, contributed to the significant incidence of teacher-led and whole-class instruction. On the other hand, the observation of the Engineering teachers in the Type D layout revealed a different teaching and learning model. While these teachers still utilised teacher-led and didactic instruction, it was shorter and refined in its intent. The analysis indicated the built pedagogy of the Type D space, somehow supported an increased prevalence of more active pedagogies working to a greater incidence of more independent learning experiences. It is a generalisation to say that Engineering and Science subjects are somewhat conceptual similar, however, it was clear that the different affordances presented by each spatial type influenced the differences in observed pedagogy and learning.

The second finding affirms the often-overlooked influence of teacher spatial competency. Even though both Lackney (2008) and Leighton (2017) focused on its theoretical development, this study does highlight its potential mediating influence, in a similar vein to that observed earlier studies at the site (Byers et al., 2014, 2018a). Early studies at this site, through analysis of teacher's voice, highlighted the differing perceptions in use, or not, of the affordances presented by different spatial types. The comparison between the Mathematics and Science teacher samples, in relatively similar spatial layouts, indicated how teachers with a more developed spatial competence can orchestrate different learning experiences. The Through use, the Mathematics sample appeared well attuned to the affordances of their traditional classroom, and how these could be used to facilitate responsive learning experiences, and increased levels of activity differentiation by students. Unlike the sequence of whole class linear progression of lessons observed in the Science classes, the Mathematics sample was more likely to create an environment that allowed students to progress from scaffolded (i.e. lower cognitions of remember/recall) through to deeper learning and thinking associated with the application of the learnt information to problems. Furthermore, the Mathematics teachers appeared more able to use the affordances of the given space to structure communities of learning, intertwined with class discussion and questioning, to scaffold this progression, despite the perceived restrictions of a traditional classroom.

These findings suggest that the LPTS observation metric, applied through a repeated measures approach, has the potential to inform evaluation of teaching and learning in different learning spaces. However, to improve the generality and validity of both the approach, the application of the LPTS metric and initial findings presented here, a longer-term evaluation of the impact of different subject types is required. Subsequent articles will focus on the more in-depth multivariate analysis of visual and nonparametric analysis to identify statistically significant changes in activities and behaviour between teachers, subjects, and spatial types.

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References

Benade, L. (2016). Is the classroom obsolete in the twenty-first century? *Educational Philosophy and Theory*, 1–12. https://doi.org/10.1080/00131857.2016.1269631.

Bielefeldt, T. (2012). Guidance for technology decisions from classroom observation. *Journal of Research on Technology in Education, 44*(3), 205–223. https://doi.org/10.1080/15391523.2012.10782587.

Blackmore, J., Bateman, D., O'Mara, J., & Loughlin, J. (2011). *Research into the connection between built learning spaces and student outcomes: Literature review*. Melbourne: Victorian Department of Education and Early Childhood Development. Retrieved from http://www.eduweb.vic.gov.au/edulibrary/public/publ/research/publ/blackmore_learning_spaces.pdf.

Brooks, D. C. (2011). Space matters: The impact of formal learning environments on student learning. *British Journal of Educational Technology, 42*(5), 719–726. https://doi.org/10.1111/j.1467-8535.2010.01098.x.

Byers, T. (2017). Development of the linking pedagogy, technology and space observational metric. In B. Cleveland, H. Mitcheltree, & W. Imms (Eds.), *What's working? 2016: Informing education theory, design and practice through learning environmental evaluation* (pp. 77–88). Melbourne: Learning Environments Applied Research Network.

Byers, T., Hartnell-Young, E., & Imms, W. (2018). Empirical evaluation of different classroom spaces on student perceptions of the use and effectiveness of 1 to 1 technology *British Journal of Educational Technology, 49*(1), 153–164. https://doi.org/10.1111/bjet.12518.

Byers, T., & Imms, W. (2014). Making the space for space: The effect of the classroom layout on teacher and student usage and perception of one-to-one technology. Paper presented at the 26th Australian Computers in Education Conference, Adelaide.

Byers, T., & Imms, W. (2016). Evaluating the change in space in a technology-enabled primary years setting. In K. Fisher (Ed.), *The translation design of schools: An evidence based approach to aligning pedagogy and learning environment design* (pp. 215–236). The Netherlands: Sense.

Byers, T., Imms, W., & Hartnell-Young, E. (2014). Making the case for space: The effect of learning spaces on teaching and learning. *Curriculum and Teaching, 29*(1), 5–19. https://doi.org/10.7459/ct/29.1.02.

Byers, T., Imms, W., & Hartnell-Young, E. (2018a). Comparative analysis of the impact of traditional versus innovative learning environment on student attitudes and learning outcomes. *Studies in Educational Evaluation, 58*, 167–177. https://doi.org/10.1016/j.stueduc.2018.07.003.

Byers, T., Imms, W., & Hartnell-Young, E. (2018b). Evaluating teacher and student spatial transition from a traditional classroom to an innovative learning environment. *Studies in Educational Evaluation, 58*, 156–166. https://doi.org/10.1016/j.stueduc.2018.07.004.

Byers, T., Imms, W., Mahat, M., Liu, K., & Knock, A. (2018). A systematic review of the effects of learning environments on student learning outcomes. *Innovative Learning Environments and Teachers Change*. https://doi.org/10.13140/RG.2.2.23918.10561.

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *The Journal of Architecture, 19*(1), 43–63. https://doi.org/10.1080/13602365.2014.882376.

Fisher, K. D. (2006). *The new learning environment: Hybrid designs for hybrid learning*. Retrieved from Melbourne: http://www.woodsbagot.com/en/Documents/Public_Research/PUBLIC2%20The%20New%20Learning%20Environment.pdf.

Gislason, N. (2010). Architectural design and the learning environment: A framework for school design research. *Learning Environments Research, 13*(2), 127–145. https://doi.org/10.1007/s10984-010-9071-x.

Hattie, J. A. C., & Donoghue, G. M. (2016). Learning strategies: A synthesis and conceptual model. *Science of Learning, 1,* 1–13. https://doi.org/10.1038/npjscilearn.2016.13.

Imms, W., & Byers, T. (2016). Impact of classroom design on teacher pedagogy and student engagement and performance in mathematics. *Learning Environments Research, 19*(2), 1–14. https://doi.org/10.1007/s10984-016-9210-0.

Imms, W., Mahat, M., Byers, T., & Murphy, D. (2017). *Type and use of innovative learning environments in Australasian schools.* ILETC Survey No. 1. Melbourne, Australia: University of Melbourne, LeARN. Retrieved from http://www.iletc.com.au/publications/reports.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1.

Lackney, J. A. (2008). Teacher environmental competence in elementary school environments. *Children, Youth and Environments, 18*(2), 133–159. www.colorado.edu/journals/cye.

Leighton, V. (2017). Teaching Space: Does a teacher's spatial competency affect their teaching and effect the different types of learning that takes place in a classroom? Paper presented at the Transitions Australasia: What is needed to help teachers better utilize space as one of their pedagogic tools, Melbourne.

Monahan, T. (2002). Flexible space & built pedagogy: Emerging IT embodiments. *Inventio*, *4*(1), 1–19. http://www.torinmonahan.com/papers/Inventio.html.

Mulcahy, D., Cleveland, B. W., & Aberton, H. (2015). Learning spaces and pedagogic change: Envisioned, enacted and experienced. *Pedagogy, Culture & Society, 23*(4), 1–21. https://doi.org/10.1080/14681366.2015.1055128.

Oblinger, D. G. (2006). Space as a change agent. In D. G. Oblinger (Ed.), *Learning spaces* (pp. 1.1–1.4). EDUCAUSE.

OECD. (2013). *Innovative learning environments.* Paris: Organisation for Economic Cooperation and Development.

Painter, S., Fournier, J., Grape, C., Grummon, P., Morelli, J., Whitmer, S., et al. (2013). *Research on learning space design: Present state, future directions.* Ann Arbor: Society for College and University Planning.

Reynard, R. (2009). Designing learning spaces for instruction, not control. *Campus Technology.* Retrieved from http://campustechnology.com/articles/2009/04/29/designing-learning-spaces-for-instruction-not-control.aspx.

Rosenshine, B. (1987). Synthesis of research on explicit teaching. In R. E. Bruce & E. E. Grimsely (Eds.), *Reading in educational supervision* (Vol. 2, pp. 145–153). Alexandria, VA: Assocation for Supervision and Curriculum Development.

Rosenshine, B. (2012). Principles of instruction: Research-based strategies that all teachers should know. *American Educator, 36*(1), 12–19, 39.

Steele, F. I. (1973). *Physical settings and organization development*. Reading: Addison-Wesiey.

Tanner, C. K. (2008). Explaining relationships among student outcomes and the school's physical environment. *Journal of Advanced Academics, 19*(3), 444–471.

Upitis, R. (2004). School architecture and complexity. *Complicity: An International Journal of Complexity & Education, 1*(1), 19–38. www.complexityandeducation.ca.

Imms, W. (2018). Innovative learning spaces: Catalysts/agents for change, or 'just another fad'? In S. Alterator & C. Deed (Eds.), *School space and its occupation: The conceptualisation and evaluation of new generation learning spaces* (pp. 107–118). Amsterdam, The Netherlands: Sense Publishing.

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Design with Knowledge—Light in Learning Environments

Imke Wies van Mil, Olga Popovic Larsen, Karina Mose, and Anne Iversen

Abstract A range of artificial lighting characteristics have been found to influence our visual and cognitive capabilities, mood, motivation and/or (social) behaviour—all affecting how we (academically) perform. One such influential characteristic is spatial contrast, or the way light is distributed in space causing a pattern of light and darkness. This study looks at if and how spatial contrast influences pupil behaviour, and specifically their ability to concentrate. We first explored whether variances in pupil noise, physical activity and mood, which have been found to affect concentration, occur when exposed to either a high or a low spatial contrast in their learning environment. Preliminary data from field experiments in a primary school indicates towards decreased noise levels and improved environmental satisfaction when a high spatial contrast condition is present. This implies improved environmental circumstances to concentrate. Further research to confirm this assumption will be undertaken.

Introduction

A significant body of evidence has been accumulated that demonstrates our physical (built) environment influences our ability to act (Gifford, 2007). This has been found particularly true for educational environments, where a range of parameters has been identified that influences our behaviour, wellbeing, and ultimately academic performance. Light is one of such influential parameters (Barrett et al., 2015). For those designing or using educational facilities, it is relevant to understand how lighting conditions may influence our ability to perform curricular

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activities. A better understanding of the relationship between indoor lighting conditions and human (learning-related) behaviour equips us to design more suitable learning environments.

Our research, embedded in the architectural practice Henning Larsen, explores this relationship specifically in public primary schools in Denmark, where recently a major educational reform took place (The Danish Ministry of Education, 2014). Greater emphasis is now put on stimulating "learning" through: physical playfulness, diversity in curricular activities, and addressing individual learning styles instead of applying a generalized approach. As a result, Danish primary schools have implemented a teaching philosophy that promotes individuality, flexibility and diversity.

Ideally, the design of spaces where this "new" learning takes place facilitates these educational principles. This environmental need has also been recognized by the Danish local governments, and a significant number of primary schools have been or are currently in the process of being renewed or refurbished. In line with this development, our research ambition became to explore how artificial lighting can play an active role in creating such supportive "new" learning environments, and simultaneously grow our knowledge on how artificial lighting influences (learning-related) behaviour of pupils in Danish primary schools.

The Influence of Artificial Light

Previous researchers studying the influence of artificial light on users of learning environments found that certain characteristics impact their visual and cognitive capabilities, biological clock, mood, motivation, and/or (social) behaviour—ultimately affecting (academic) performance. Most evident are characteristics of "light" such as intensity, colour temperature and combinations thereof (Sleegers et al., 2012; Mott et al., 2012; Wessolowski et al., 2014), as well as "system" characteristics such as glare, flicker, and control (Winterbottom & Wilkins, 2009). Yet little studied, but possibly equally influential are "spatial" characteristics of artificial light, which co-define the appearance of (Boyce, 2014) and consequently the perceived atmosphere in (Vogels, 2008) a space. One of these is spatial contrast, which is the result of how (artificial) light is distributed in a space, creating a pattern of relative light and darkness. A pattern with great variation is considered high-contrasting or non-uniform—also referred to as "dramatic", whereas a pattern with little variation is considered low-contrasting or uniform—also referred to as "plain" (Flynn et al., 1973, 1977, 1979; Govén et al., 2011; Boyce, 2014).

The main difference between light- and system characteristics, and spatial contrast is that these first two are *product* variables, defined by the technical characteristics of the lighting installation fitted. Whereas spatial contrast is a *design* variable, meaning that it is tailored by the architect to fabricate the intended spatial experience (Boyce, 2014), and herewith a perceived atmosphere (Vogels, 2008). As our research is embedded in architectural design practice with a strong emphasis on optimizing the spatial experience in our built environments, exploring the influence of spatial contrast in learning environments became the theme to investigate further.

The Architect's Responsibility

Arguably, architects should treat artificial light with similar importance as they do for natural light, which is commonly considered a significant design criterion, to guarantee a healthy and stimulating indoor learning climate. It seems well recognized that daylight, when utilized wisely, can improve our wellbeing, indoor experience and academic performance (Gifford, 2007). For instance, one frequently referenced study verified that allowing the right amount of daylight indoors helps students to learn faster and achieve better results (Heschong Mahone Group, 2003; World Green Building Council, 2013). In addition to attending to its quantitative values, daylight is also considered a rich qualitative resource, in particular when it comes to designing a dynamic learning environment with variations of intensities, colour, orientation and movement of natural light through a space. Such variations have been found to influence our spatial experience over time, and thereby to increase motivation and our ability to learn and be creative (Jensen et al., 2012).

Nonetheless, the availability of natural light in interior spaces will vary depending on location, orientation, time of day and season, and artificial light is often required to complement or supplement inadequacies. As a consequence, artificial light has significant influence on our spatial experience and should likewise be a design criterion on the architect's agenda. However, when interviewing numerous Danish educational architects about their (artificial light) design practice, it became apparent that it is not (yet) considered attending to beyond meeting the basic illumination requirements in the national building regulations. These merely safeguard that the "average user" is able to comfortably move, read and write by prescribing a maintained average illumination and uniformity level for all hours of use. With this in mind, we explored the consequences of this approach for the indoor lighting conditions in contemporary learning spaces.

Artificial Light in Today's Learning Spaces

Field studies in eight Danish primary schools (of which four examples are shown in Fig. 1a–d) revealed the common application of "one-type-fits-all" ceiling-based artificial lighting systems, resulting in a relatively uniform, or low contrast, distribution of light. The consequential spatial appearance, or perceived spatial atmosphere, was often described as "functional", but "dull", "uninspiring", or even "hospital-like", i.e. unpleasant. When discussing how these systems are used during teaching hours, educators' responses did not go much beyond: "… switching it ON at the start of day,

a. Lyngby Skole

b. Albertslund Skole

c. Sophia Skole

d. Ørestad Skole

Fig. 1 Impressions of artificial lighting conditions in primary Danish learning spaces

and OFF at the end”. But when asked to elaborate on their experience with and/or use of light in general while teaching, several went on to describe how they did use it in some form. In most examples, their intention is to create (in their words) the “right” atmosphere to promote behaviour and mood that benefits pupils’ ability to concentrate. Some did so by deliberately increasing or decreasing the light levels based on the type of curricular activity at hand. Others used their own sources of light such as candles or simple plug-in table luminaires to promote local focus and quietness, or to cluster pupils’ attention in small groups. These and other examples revealed that a number of educators sought to create a particular atmosphere intended to foster focus and concentration among pupils when deemed valuable (e.g. certain curricular activities).

Atmosphere to Concentrate

Previous research has revealed that deliberate design with light and darkness co-defines the appearance of a space (Boyce, 2014), which contributes to our experience of atmosphere (Vogels, 2008). This is, among others, shaped by the way light is distributed in a space, or spatial contrast, as described above. Our field studies in eight primary learning environments revealed that a low-contrast, or uniform, distribution of artificial light has become widespread. The resulting luminous atmosphere is described as functional, though uninspiring and dull. The educators who try to modify this atmosphere by using local light sources instead of the generic ceiling lighting to promote focus and concentration are effectively changing the manifestation of spatial contrast in their environment.

These findings suggest that spatial contrast has the potency to be an instrument for educators to orchestrate a different-then-normal atmosphere in their learning environment, and in their view, aid concentration during certain curricular activities. If this idea could be demonstrated to be true, then artificial lighting might receive greater attention in learning space design. It was therefore further explored in a design context by hosting workshops with a number of architects at Henning Larsen, which led to the formulation of the following hypothesis:

> Focussed, local light leads to high-spatial contrast that co-constructs an atmosphere that promotes pupil behaviour and mood states benefitting their ability to concentrate

These workshops also informed the design of an artificial lighting prototype capable of creating the wished for high-spatial contrast by educators on-demand.

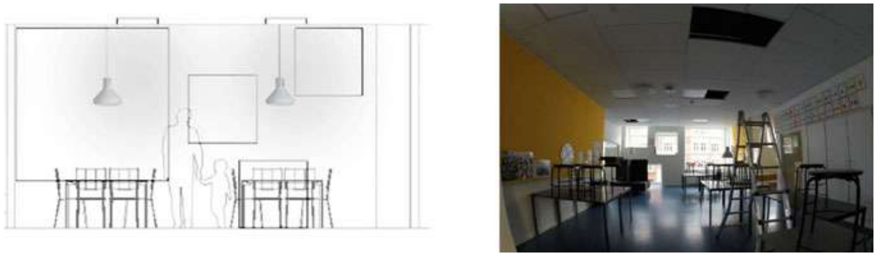
The "Living Lab"

To validate this hypothesis, this prototype has been implemented in four learning spaces of Frederiksbjerg folkeskole (Fig. 2), a new public school located in Aarhus (DK). This school, inaugurated in August 2016 and co-designed by Henning Larsen, is considered: "a benchmark example of the new educational ideals translated into supportive learning environments" (Norhcon, 2016), and was therefore thought to be a credible example to evaluate our hypothesis in the context of the new reform.

Fig. 2 Impression of the new Frederiksbjerg Skole in Aarhus (DK). Photo and image credits: Henning Larsen, © Hufton+Crow

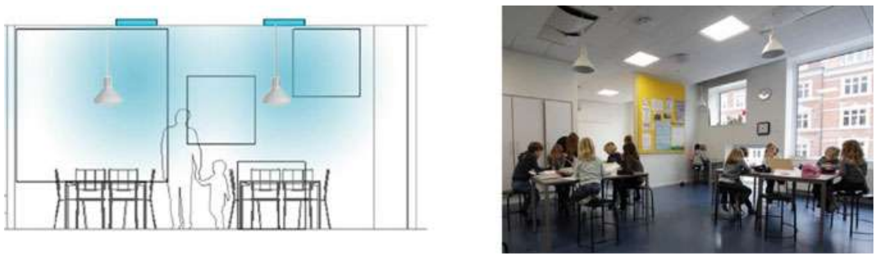
The four spaces selected are located in close proximity and have relatively similar natural light and spatial layout characteristics. Two spaces are used each by one group of 1st to 3rd grade pupils (aged 6–8 years) and host a varied palette of curricular activities. The other two spaces are used by eight rotating groups of 4th to 6th grade pupils (aged 9–12 years) for 90-minute mathematics lessons. Both demographic and curricular settings were thought to benefit from improved pupil concentration.

The "prototype design" has been implement in addition to the existing "default design" in these four spaces. The **default lighting design** consist out of six evenly spread ceiling luminaires. Users may choose to either switch all six luminaires: OFF (option A, Fig. 3a, b) or ON (option B, Fig. 4a, b)—with an option to increase or decrease the overall light level. The default ON state causes a low-contrast distribution of light and complies with current Danish building regulations to provide for an average "working area" illumination level of 300 lx with a uniformity ratio of 0.6 during all hours of use. The **prototype lighting design** consists out of the default system complemented by six additional suspended pendants above typical work surfaces (aka working desks) permitting for local, focussed light at eye-level. Users may choose to switch all lighting OFF (option A, Fig. 3a, b), or to activate



a Option A (all luminaires OFF) *b Option A (all lighting OFF)*

Fig. 3 Option A - No artificial lighting activated - daylight only. **a** Sketch depicting artificial lighting Option A. **b** Photo of the classroom with artificial lighting Option A activated. Image credits: Henning Larsen, Imke Wies van Mil. Photo credits: Henning Larsen, Halfdan Trolle

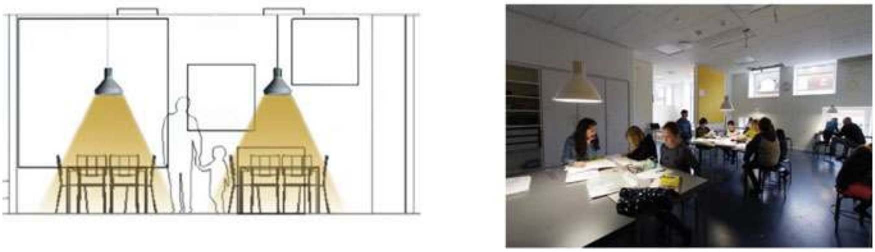


a Option B (ceiling lighting ON) *b Option B(ceiling lighting ON)*

Fig. 4 Option B - Ceiling lighting activated. **a** Sketch depicting artificial lighting Option B. **b** Photo of the classroom with artificial lighting Option B activated. Image credits: Henning Larsen, Imke Wies van Mil. Photo credits: Henning Larsen, Halfdan Trolle

a Option C (ceiling + pendants ON) *b Option C (ceiling+pendant ON)*

Fig. 5 Option C - Ceiling and pendant lighting activated. **a** Sketch depicting artificial lighting Option C. **b** Photo of the classroom with artificial lighting Option C activated. Image credits: Henning Larsen, Imke Wies van Mil. Photo credits: Henning Larsen, Halfdan Trolle



a Option D (pendant lighting ON) *b Option D (pendant lighting ON)*

Fig. 6 Option A - Pendant lighting activated. **a** Sketch depicting artificial lighting Option D. **b** Photo of the classroom with artificial lighting Option D activated. Image credits: Henning Larsen, Imke Wies van Mil. Photo credits: Henning Larsen, Halfdan Trolle

the default ceiling lighting only (option B, Fig. 4a, b) which results in a low-contrast distribution of light. They may also choose to activate both the default and new pendant system simultaneously (option C, Fig. 5a, b), or the pendant system only (option D, Fig. 6a, b). Both results in high or very high-contrast distributions of light.

To evaluate the validity of our hypothesis, the influence of the high-contrast prototype lighting design on pupil behaviour and their mood, was compared to that presented under influence of the low-contrast default lighting design.

Data Collection

To evaluate whether the prototype design effected pupil concentration, we looked at two specific behavioural pupil actions: their noise levels and their physical activity during a curricular session. A correlation is thought to exist between the level of noise pupils are exposed to (including their own noise), and their ability to concentrate (Klatte et al., 2013). Similarly, this is the case for physical activity, specifically the length of time seated at one place. It is anticipated that for our hypothesis to be considered valid, the prototype design should lead to lower average student noise and longer average time seated at the working place. In addition, we also assessed variances in pupil's responses towards their learning environment, anticipating greater satisfaction to positively influence mood and motivation. To exclude as many intervening variables as possible, a range of other (environmental) factors have been measured as well.

A mixed-method approach was applied to collect the described quantitative and qualitative data. This included anthropological techniques such as non-participant in classroom observations, semi-structured interviews and focus groups with educators and pupils, as well as continuous measurements of the indoor climate variables, and recordings of the lighting system usage. Noise levels were recorded with sound-level meters, and physical activity by observations and video documentation. Data collection took place during the months of February, March and April of 2017. In each of the four learning spaces, the pupils and their educators experienced the two lighting designs in succession for three continuous weeks. Two of the spaces (one lower, one mid-level) used the default lighting design during the first three-week interval, and the prototype lighting design during the following three weeks. The other two rooms experienced both situations in opposite order. The weekly schedule of curricular activities in each space, as well as their furniture and spatial layouts were kept consistent during the entire research period.

Preliminary Findings

Currently we are in the process of analysing our data. We recognise we are working in a specific cultural context of education and use of light. Preliminary findings, however, indicate support for our hypothesis that high spatial contrast, created by focussed, local light distribution, lowers average pupil noise. An initial analysis of the sound data collected indicates that during activation of the local pendant lighting, the average noise level in these rooms decreased up to 10%, which is deemed significant. In addition, a positive increase in environmental satisfaction by both educators and pupils was found, and educators preceived (but could not document) longer periods of concentration among pupils. Further analysis of video recordings and observational notes is required.

The immediate outcome is however that *Frederiksbjerg skole* requested for the prototype lighting scenario to be made into a permanent installation (Fig. 7), and to be replicated in other spaces too. Not only is this a successful conclusion for our design-led research approach, the installation also allows for a longer period of study during Autumn 2017, contributing data for further analysis. Furthermore, additional pupil exercises, both quantitative and qualitative in nature, will be added to our data set. Analysis of these exercises may indicate more accurately what the impact of the new lighting scenario is on the ability of students to concentrate.

Fig. 7 Permanent lighting installation inaugurated by the pupils and educator. Photo credits: Henning Larsen, Imke Wies van Mil

If further data analysis backs up our initial findings described above, we might may conclude that current buildings regulations do not promote the most favourable luminous learning environments in Denmark and changes should be considered.

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References

Barrett, P., Zhang, Y., Davies, F., & Barrett, L. (2015). *Clever rooms—Summary report of the HEAD Project*. University of Salford, Manchester. ISBN 978-1907842634.

Boyce, P. R. (2014). *Human factors in lighting*. 3rd edition. CRC Press. Boca Raton, Florida. ISBN 978-1439874882.

Boyce, P. R. (2014b). Editorial: Light distribution—a missing variable. *Lighting Research and Technology, 46,* 617. https://doi.org/10.1177/1477153514556940.

Flynn, J. E., Spencer, T. J., Martyniuk, O., Hendrick, C. (1973). Interim study of procedures for investigating the effect of light on impression and behavior. *Journal IES—Transaction*, 87–94. http://media.ies.org/docs/research/100papers/040.pdf.

Flynn, J. E. (1977). A study of subjective responses to low energy and non-uniform lighting systems. *Journal IES Lighting Design + Application*, *7*, 167–179.

Flynn, J. E., Hendrick, C., Spencer, T. J., Martyniuk, O. (1979). A guide to methodology procedures for measuring subjective impressions in lighting. *Journal IES Lighting Design + Application*, *8*, 95–110. http://media.ies.org/docs/research/100papers/041.pdf.

Gifford, R. (2007). *Environmental psychology—Principles and practice.* 4th edition. Optimal Books. ISBN 978-0968854310.

Govén, T., Laike, T., Raynham, P., & Sansal, E. (2011). Influence of ambient light on the performance, mood, endocrine systems and other factors of school children. *The CIE 27th Session. South Africa: Sun City*.

Heschong Mahone Group—California energy commission (2003). Windows and rooms: A study of student performance and the indoor environment. Technical Report. http://www.energy.ca.gov/2003publications/CEC-500-2003-082/CEC-500-2003-082-A-08.PDF.

Jensen, J. L., Schjødt-Pedersen, M., Houlberg Abildhauge Olesen, M., Brandt Østerby, A., Rebsdorf Rostved, M., & Henning Larsen Architects. (2012). *Learning spaces: Interviews about and case studies of learning environments of tomorrow*. Retrieved from https://issuu.com/henninglarsenarchitects/docs/learning_spaces_en_web_red.

Klatte, M., Bergström, K., & Lachmann, T. (2013). Does noise affect learning? A short review on noise effects on cognitive performance in children. *Frontiers in Psychology*; *4*, 578. https://doi.org/10.3389/fpsyg.2013.00578.

Mott, M., Robinson, D. H., Walden, A., Burnette, J., & Rutherford, A. S. (2012). Illuminating the effects of dynamic lighting on pupil learning. *SAGE Open*. https://doi.org/10.1177/2158244012445585.

Norhcon. (2016). Årets skolebyggeri. https://nohrcon.dk/information/aarets-skolebyggeri-2016-frederiksbjerg-skole-i-aarhus/.

Sleegers, P. J. C., Moolenaar, N. M., Galetzka, M., Pruyn, A., Sarroukh, B. E., & Van der Zande, B. (2012). Lighting affects pupils' concentration positively: Findings from three Dutch studies. *Lighting Research and Technology, 45,* 159–175. https://doi.org/10.1177/1477153512446099.

The Danish Ministry of Education. (2014). Improving the public school—Overview of reform of standards in the Danish public school (primary and lower secondary education). http://www.unesco.org/education/edurights/media/docs/10354f6c8699be7af856353a08a0e2681f957cfa.pdf.

Vogels, I. (2008). Atmosphere metrics—Development of a tool to quantify experienced atmosphere. In: J. Westerink, M. Ouwerkerk, T. J. M. Overbeek, W. PasveerF. Pasveer (Eds.) *Probing experience—From assessment of user emotions and behaviour to development of products*. Philips Research Book Series, Volume 8. Springer Science & Business Media, pp. 25–41.

Wessolowski, N., Koenig, H., Schulte-Markwort, M., & Barkmann, C. (2014). The effect of variable light on the fidgetiness and social behavior or pupils in school. *Journal of Environmental Psychology, 39,* 101–108. https://doi.org/10.1016/j.jenvp.2014.05.001.

Winterbottom, M., & Wilkins, A. (2009). Lighting and discomfort in the room. *Journal of Environmental Psychology, 29,* 63–75. https://doi.org/10.1016/j.jenvp.2008.11.007.

World Green Building Council (2013). The business case for green building: A review of the costs and benefits for developers, investors and occupants. Technical Report. http://www.worldgbc.org/sites/default/files/Business_Case_For_Green_Building_Report_WEB_2013-04-11-2.pdf.

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Exploring the Relationships Between Learning Space and Student Learning in Higher Education: A Comparative Case Study in China

Ji Yu

Abstract The landscape of learning space design in higher education is undergoing a transformation. During the past decade, flexible, innovative learning spaces have been established around the world in response to the changing perspectives on how knowledge is discovered and what constitutes important and appropriate higher education in contemporary society.

Introduction

The landscape of learning space design in higher education is undergoing a transformation. During the past decade, flexible, innovative learning spaces have been established around the world in response to the changing perspectives on how knowledge is discovered and what constitutes important and appropriate higher education in contemporary society (e.g. Beetham & Sharpe, 2013; Harrison & Hutton, 2014; JISC, 2006; Oblinger, 2006). Characteristics of these spaces include motivating learners and promoting learning as an activity, supporting interdisciplinary and collaborative learning, providing a personalised and inclusive environment and being flexible in the face of changing needs. Technology usually plays a vital part in achieving these aims.

In contrast with the school sector, the existence of evidence on the link between spatial design and pedagogical effectiveness in higher education is still sparse. Some exceptions include the works of Brooks (2011, 2012) and Walker et al. (2011), who have partnered with instructors and conducted a series of quasi-experimental studies to investigate the impact of learning space upon students' learning behaviour and learning outcomes. It has been argued that there is a great need for rigorous and multilayered models and knowledge of the role of learning space in influencing and

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supporting student learning in higher education (Ellis & Goodyear, 2016; Mirijamdotter et al., 2006; Strange & Banning, 2001; Temple, 2008). The present study is an attempt to remedy the situation.

Student Learning Research in Higher Education and Discussions on "Chinese Leaners"

This study draws on theories and concepts in *student learning research* (Biggs, 1993; Richardson, 2000), mainly situated in the cognitive psychology of education, in order to provide an insightful and solid way to understand the complex student learning process and discuss relatively 'desirable' or 'less desirable' learning in contemporary society. Student learning has been an ongoing subject of study, and it includes the following outline frameworks and broad concepts (Entwistle et al., 2002): (1) Curriculum frameworks and their influences on learning; (2) students' approaches to learning; (3) the teaching–learning context (environment) and students' perceptions of it; and (4) learning outcomes.

The theoretical underpinnings of this study are particularly rooted in the literature concerning Students' Approaches to Learning (SAL). The research tradition that originated in the 1970s has exerted a seminal impact in studying how to assess and improve the quality of student learning in higher education. An approach to learning is conceptualised in terms of cognitive strategies and motivation. Two distinct approaches have been identified repeatedly (Biggs 1988; Entwistle & Ramsden 1983; Marton & Säljö, 1984; Schmeck, 1988). *Surface approaches to learning* refer to students employing surface learning processes (e.g. rote memorisation of course materials) for the purpose of assessment, while *deep approaches to learning* mean that students use deep learning processes (e.g. seeking for meaning, understanding and relating ideas) with an intrinsic interest in learning and understanding.

Over the last few decades, the research domain has further flourished. Researchers (Short & Weisberg-Benchell, 1989; Vermunt & Verloop, 1999) have compared different taxonomies in studies and categorised them into three main dimensions: *cognitive processing activities, affective or motivational learning activities and regulative activities.* Cognitive processing activities refer to how students engage in processing subject matter, which leads directly to learning outcomes. Affective learning activities are related to the emotions that arise during learning, and the activities that students employ that lead to a mood may have a positive, neutral or negative effect on the learning processes. Regulative activities refer to students exerting control over their cognitive and affective activities during learning. This categorisation serves as a point of departure in conceptualising student learning in the present study.

In contrast with the extensive literature in the west, this area of research in China is in its infancy—only a small number of studies have been published. There have been some discussions on "Chinese learners"—an old stereotype of Chinese students is that they are passive rote learners, concerned mainly with memorising the information (Ballard & Clanchy, 1984; Murphy, 1987; Samuelowicz, 1987). But recent questionnaire and interview-based research refute this idea as Chinese students from East Asian countries outperform their Western counterparts in international comparisons (Hau & Ho, 2010); and it is suggested that, unlike Western students who normally adopt either a deep or surface approach to learning, ethnically Chinese students tend to adopt a distinctive approach to studying that combines memorising with understanding (Kember, 1996; Watkin & Biggs, 1996).

However, it should be noted that the majority of existing evidence has not been based on students from mainland China but on ethically Chinese students in Hong Kong, where a Western higher educational system is operated. Only very few studies have studied the mainland Chinese students (Lu, 2003; Richardson & Sun, 2016; Zhu et al., 2008a, b), and current evidence is far from sufficient to gain a holistic and accurate picture of "Chinese learners" and to conclude how Chinese students go about their learning are culturally determined. Furthermore, as China is composed of 56 ethnic groups and the uneven education development between different regions is still manifested, treating "Chinese learners" as a homogeneous group may be simplistic and inappropriate.

The Present Study

This study aims to explore the relationship between learning space and student learning in higher education through empirical work. It employs a comparative case study design. The case study allows for a rich, vivid description and an in-depth analysis of certain phenomena, and is powerful in revealing multi-fold dimensions of exploratory research. Moreover, multiple-case study helps to deepen understanding and enhance generalisability (Geertz, 1973; Yin, 2009). The study highlights the crucial student view as the current spatial design in higher education lacks a student's perspective. Bennett (2007) has argued that students have their own ideas about learning space and can be very articulate in discussing the strengths and shortcomings of designed spaces.

Method

Context: Two Contrasting Learning Spaces

Two contrasting learning spaces in a middle-sized Chinese university (alias "N University") were selected for investigation. Both were generic learning spaces designed for all types of students. N University and the two cases were selected for two main reasons. First, N University is committed to the highest standards of research and teaching in architecture and civil engineering, both in China and internationally. It founded its own Architectural Design and Research Institute in the late 1950s, which is now one of the leading design institutes in China and reputable for its campus building design. On the campus of N University, there are many traditional, didactic spaces built in the 1950s, as well as a series of flexible, innovative learning spaces built since the 1990s. The learning paradigms that drive this transformation provide an intriguing background for the study, and the tension between the two different types of learning spaces are currently common in many other places. Secondly, the selection was made also based on the consideration of accessibility to research participants and relevant resources (e.g. the archives).

Document analysis and semi-structured interviews with educators and designers reveal that the two spaces are embedded with different intentions. Space A (Fig. 1) places great emphasis on discipline and collectivism, reflected in its traditional academic architectural style, plain colours and didactic interior space. Space B (Fig. 2) is designed to create a relaxing, interdisciplinary environment with a rich colour scheme, comfortable furnishing, spatial division and flexibility and the creation of a sense of ownership and autonomy. To some extent, the two spaces represent two distinct pedagogical philosophies and teaching approaches: in Space A, knowledge is mainly presupposed as transmission from an external source to the learner, and the teacher is the directing agency. Students are expected to be disciplined and well behaved for the acquisition of knowledge. Not surprisingly, a conventional,

Fig. 1 The typical classroom in Space A (Photo by the author, 2015)

Fig. 2 Multi-purpose lecture room in Space B (Photo source: Sino-Finnish Centre)

teacher-focused approach is used in which the teacher determines the subject matter, often in the form of books or chapters, the content of which has to be learned.

By contrast, in Space B learning is more closely conceived as an active process of knowledge construction. As the designer describes, “we use vivid colour, natural materials, and displays (things you will never see in common teaching buildings) to inspire students’ ideas and imagination…students are not judged by correct or wrong answers; instead, they are encouraged to think and participate actively”. Space B provides a number of courses on product design and innovation, which normally employs a project-based learning approach with students from different disciplines choosing authentic, real-life assignments or problems to work on, and working in small groups. The role of the teacher is to guide the groups and provide feedback when necessary. Students can use both spaces freely when there are no scheduled classes and events.

Focus Group Interviews

Prior to this study, a survey was conducted with 320 students on their learning strategies within the two spaces. The findings suggested that students in Space A and Space B differed in many respects in terms of the central dimensions of learning as noted above—cognitive strategies, regulative strategies and learning motivations

(Yu et al., 2019). However, questionnaires gave limited information about how the differences occurred and what specific role space played in the complicated learning process; neither they could reveal the crucial student view on the phenomenon. Thus, in this study, to explore students' experiences and attitudes further in depth, students were recruited to participate in focus group interviews (FGIs), in which they were asked a series of open-ended questions about (1) how they understood 'learning space'; (2) how they learned within the space where the FGI took place; (3) how they considered the impact of space on their learning; and (4) how they responded to the previous survey results. The researcher stayed open to new ideas put forward by participants, and probes were used during the process. To reduce the influence of dominant voices and to obtain comparable data from all respondents, in the middle of the FGIs, students were given a chance to independently write down the influential elements of a space to their learning.

Participants were selected for each FGI with the aim of capturing as much variation as possible on the following variables: gender, year of study and academic discipline. This was based on the consideration that both spaces are generic learning spaces, and also because previous student learning research has shown that these variables are related to how students go about their learning (Richardson, 2000; Vermunt, 2005). The group size was set at four to six participants after a pilot study. Finally, six FGIs with a total of 28 participants were conducted. Each FGI lasted between 1 h 40 min and 2 h.

Data Analysis

The recordings of all FGIs were manually transcribed. Coding was conducted, which was an iterative process before arriving at stable elements and categories. Drawing on the conceptual basis of student learning as described above, the development of specific code scheme used a bottom-up strategy to produce the results through a more emergent encounter with the data themselves. About 20% of the overall transcriptions were coded by a second independent researcher to assess the inter-rater reliability. Below four overarching themes regarding the alignment between learning space and student learning are outlined, and the identified codes are indicated with ''.

Selected Results

Theme One: Learning Space and Students' Conceptions of Learning

On the whole, this theme is associated with how students view and conceive their learning. Students in Space A mostly saw learning space simply as a physical site for learning, as they considered learning is 'the increase of knowledge' and 'the acquisition of facts and skills', which can be retained and/or utilised in practice. In contrast, students in Space B discussed more about 'cooperation' and 'interpretation' aimed at the understanding of reality, and paid more attention to intangible benefits of learning space, for instance, 'enrichment of learning opportunities' and 'possibility of 'communication'.

Theme Two: Learning Space and Cognitive Aspects of Learning

Students described that learning space is related to how they process their subject matter in a particular way: they were more likely to use 'listening/memorising' in a traditional space like Space A, and more engaged in 'relating/structuring/creating thinking' and 'group discussion' in an innovative learning environment like Space B. It means that student learning in Space A is engaged as a process of listening to the instruction of the teacher and repeating definitions, formulas, memorising theories and rehearsing subject matter regularly in the conventional classroom, while in Space B, students reported a collaborative process of looking for connections between different parts and the merging of new ideas.

Theme Three: Learning Space and Affective Aspects of Learning

Space is also associated with affective and motivational aspects of student learning, including their 'learning motivation', 'emotions' and 'concentration effort'. This means in the FGIs: (1) Students described a reason or reasons for acting or behaving in a particular way in a space, especially the reason in deciding where to learn. (2) Students discussed either positive feelings of happiness, ownership, self-confidence when they learned within the space; or negative emotions, such as anxiety, stress, insecurity and helplessness. (3) Students also talked about the action-distracting, task-irrelevant emotions that arise during their learning within the space. As a student summarised at the end of one FGI:

> If we could divide the composition of a learning space into three levels of factors—some level largely determines whether I will choose to learn or not learn there, the others affect the emotions during my learning, and another is associated with the degree of how effectively I can learn. All these factors of space, through exerting influence on my subjective feeling, willingness, self-initiation and effectiveness of learning, consequently impact upon the attitude, method and outcome of my learning.

Theme Four: Learning Space and Regulative Aspects of Learning

Learning space is also in relation to students' regulative learning activities. The data easily distinguish between 'self-regulation' and 'external regulation'—the former refers to students' self-initiated orienting, planning and adjustment of their learning process and activities through their examination of characteristics of the learning task and the situation within the learning space, while the latter is related to the control of teaching, other students and the surrounding events. 'Flexibility of space' in Space B facilitates students' 'self-regulation', while a conventional classroom with 'fixed seating arrangement' like Space A engenders a feeling of tension and relates to 'external regulation'. Below are two examples:

> (A student in Space A) When I learn here, the surrounding people have an effect on me, I guess, it is called 'group effect'. If others around you are playing or doing something irrelevant, I won't have much mood for learning.
>
> (A student in Space B) When I learn here, for instance, I need to draw something, then I can easily get a small whiteboard to clear my mind. I feel I can control something by myself, make adjustments and go back to learning.

Conclusion

The initial motivation for the present study derives from the curiosity about two fundamental questions rooted in learning space research: Does it really matter where students learn? How does it matter for student learning? Research on learning spaces and theories of student learning styles in higher education are rarely connected; this chapter tries to provide a window into what that phenomenon may encompass. It draws, from a larger study, a selection of themes and suggests that, with these participants in a Chinese setting, an innovative learning environment can lead to a crucial change in students' views on learning—from the acquisition of facts and skills to an active constructive process, and consequently facilitate a more collaborative, self-regulated, problem-based learning approach. As a number of empirical studies have shown that these learning strategies are associated with better learning outcomes (see e.g. Biggs, 1999; Van Rossum & Schenk, 1984; Vermunt, 2003), we may conclude that an innovative learning environment like Space B does support a more desirable approach to learning in higher education than a traditional classroom like Space A.

The results also suggest that students' emotional reactions and motivation consequences of the attributes of a space need to be carefully considered during design and in the ongoing management. Many learning spaces (like the two investigated here) are not only designed for teaching purposes but also for students' self-study activities. Therefore, students' attitudes towards a space not only affect their learning processes in class but also relate to where students choose to learn after class and how efficiently a space is utilised. In terms of the generalisability of the findings, this study takes place in China, but there is no clear evidence showing that participants' use of learning space is culturally determined. Meanwhile, the two selected cases are representative in terms of their contrasting pedagogical aims and physical features, which are currently common in many other places. From this point of view, the results are transferrable in different contexts.

The theoretical rationale underpinning *student learning research* may be worthy of consideration by learning space researchers as the multifacetedness of learning has been investigated extensively in this area, providing greater insight into the dynamic learning process and a number of formal inventories to measure student learning. In making an alliance between our understanding of pedagogy, space and learning, the integration between two research domains is likely to generate a fruitful prospect. It is hoped that this study sheds some light on this large issue that requires substantial research in the future.

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References

Ballard, N., & Clanchy, J. (1984). *Study abroad: A manual for Asian students.* Kuala Lumpur: Longman.

Beetham, H., & Sharpe, R. (Eds.). (2013). *Rethinking pedagogy for a digital age.* New York: Routledge.

Bennett, S. (2007). Designing for uncertainty: Three approaches. *The Journal of Academic Librarianship, 33*(2), 165–179. https://doi.org/10.1016/j.acalib.2006.12.005.

Biggs, J. B. (1988). Assessing student approaches to learning. *Australian Psychologist, 23*(2), 197–206. https://doi.org/10.1080/00050068808255604.

Biggs, J. (1993). What do inventories of students' learning processes really measure? A theoretical review and clarification. *British Journal of Educational Psychology, 63,* 3–19. https://doi.org/10.1111/j.2044-8279.1993.tb01038.x.

Biggs, J. (1999). *Teaching for quality learning at university: What the student does.* Buckingham: SRHE & Open University Press.

Brooks, C. (2011). Space matters: The impact of formal learning environments on student learning. *British Journal of Educational Technology, 42*(5), 719–726. https://doi.org/10.1111/j.1467-8535.2010.01098.x.

Brooks, C. (2012). Space and consequences: The impact of different formal learning spaces on instructor and student behaviour. *Journal of Learning Spaces, 1*(2). Retrieved from http://libjournal.uncg.edu/index.php/jls/article/view/285.

Ellis, R. A., & Goodyear, P. (2016). Models of learning space: integrating research on space, place, and learning in higher education. *Review of Education, 4*(2), 149–191. https://doi.org/10.1002/rev3.3056.

Entwistle, N., & Ramsden, P. (1983). *Understanding student learning*. London: Croom Helm.

Entwistle, N., McCune, V., & Hounsell, D. (2002). *Occasional report 1: Approaches to studying and perceptions of university teaching-learning environments: concepts, measures and preliminary findings*. Retrieved from http://www.ed.ac.uk/etl.

Geertz, C. (1973). *The interpretation of cultures*. New York: Basic Books.

Harrison, A., & Hutton, L. (2014). *Design for the changing educational landscape: Space, place and learning*. Abingdon: Routledge.

Hau, K.T., & Ho, I. T. (2010). Chinese students' motivation and achievement. In M. H. Bond (Ed.), *Oxford handbook of chinese psychology* (pp. 187–204). Oxford: Oxford University Press.

Joint Information Systems Committee (JISC) (2006). *Designing spaces for effective learning: A guide to 2*1st century learning space design. Retrieved from http://www.jisc.ac.uk/whatwedo/programmes/elearninginnovation/learningspaces.aspx.

Kember, D. (1996). The intention to both memorise and understand: Another approach to learning? *Higher Education, 31*(3), 341–354. https://doi.org/10.1007/BF00128436.

Lu, G. (2003). 大学生学习风格量表的设计与开发 [The development of the inventory of learning styles for undergraduate students]. *Journal of Xi'an Jiaotong University (Social Sciences), 23*(2), 86–97. https://doi.org/10.3969/j.issn.1008-245X.2003.03.017.

Marton, F., & Säljö, R. (1984). Approaches to learning. In F. Marton, D. Hounsell, & N. Entwistle (Eds.), *The experience of learning* (pp. 36–55). Edinburgh: Scottish Academic Press.

Mirijamdotter, A., Somerville, M. M., & Holst, M. (2006). An interactive and iterative evaluation approach for creating collaborative learning environments. *The Electronic Journal of Information Systems Evaluation*, *9*(2), 83–92. Retrieved from https://www.researchgate.net/publication/228627177_An_interactive_and_iterative_evaluation_approach_for_creating_collaborative_learning_environments.

Murphy, D. (1987). Offshore education: A Hong Kong perspective. *Australian Universities' Review, 30*(2), 43–44. Retrieved from https://files.eric.ed.gov/fulltext/EJ364973.pdf.

Oblinger, D. G. (2006). *Learning spaces*. EDUCAUSE. Retrieved from https://www.educause.edu/research-and-publications/books/learning-spaces.

Richardson, J. T. E. (2000). *Researching student learning: Approaches to studying in campus-based and distance education*. Buckingham, UK: Open University Press.

Richardson, J. T. E., & Sun, H. (2016). Approaches to studying among international students from China. In D. Jindal-Snape & B. Rienties (Eds.), *Multi-dimensional transitions of international students to higher education* (pp. 106–122). New York: Routledge.

Samuelowicz, K. (1987). Learning problems of overseas students: Two sides of a story. *Higher Education Research and Development, 6*(2), 121–133. https://doi.org/10.1080/0729436870060204.

Schmeck, R. R. (1988). *Learning strategies and learning styles*. New York: Plenum Press.

Short, E. J., & Weisberg-Benchell, J. A. (1989). The triple alliance for learning: Cognition, metacognition and motivation. In C. B. McCormick, G. E. Miller, & M. Pressley (Eds.), *Cognitive strategy research: From basic research to educational applications* (pp. 33–63). New York: Springer Verlag.

Strange, C., & Banning, J. (2001). *Educating by design: Creating campus learning environments that work*. San Francisco: Jossey-Bass.

Temple, P. (2008). Learning spaces in higher education: An under-researched topic. *London Review of Education, 6*(3), 229–241. https://doi.org/10.1080/14748460802489363.
Van Russum, E, J., & S. M. Schenk (1984). The relationship between learning conception, study strategy and learning outcome. *British Journal of Educational Psychology, 54*(1), 73–83. https://doi.org/10.1111/j.2044-8279.1984.tb00846.x.
Vermunt, J. D. (2005). Relations between student learning patterns and personal and contextual factors and academic performance. *Higher education*, *49*(3), 205–234. https://doi.org/10.1007/s10734-004-6664-2.
Vermunt, J. D. (2003). The power of learning environments and the quality of student learning. In E. de Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), *Powerful learning environments: Unravelling basic components and dimensions, Advances in learning and in learning and instruction series* (pp. 109–124). Oxford: Pergamon.
Vermunt, J. D., & Verloop, N. (1999). Congruence and friction between learning and teaching. *Learning and Instruction, 9*(3), 257–280. https://doi.org/10.1016/S0959-4752(98)00028-0.
Walker, J. D., Christopher, D., Brooks, C., & Baepler, P. (2011). Pedagogy and space: Empirical research on new learning environments. EDUCAUSE. Retrieved from http://www.educause.edu/erp/article/pedagogy-and-space-empirical-research-new-learning-environments.
Watkins, D. A., & Biggs, J. B. (1996). *The Chinese Learner: Cultural, psychological and contextual Influences*. Hong Kong: Comparative Education Research Centre, University of Hong Kong.
Yin, R. K. (2009). *Case study research: Design and methods*. London: Sage.
Yu, J., Vermunt, J. D., & Burke, C. (2019). Students' learning patterns and learning spaces in higher education: An empirical investigation. Manuscript submitted for publication.
Zhu, C., Valcke, M., & Schellens, T. (2008a). A cross-cultural study of Chinese and Flemish university students: Do they differ in learning conceptions and approaches to learning? *Learning and Individual Differences, 18*(1), 120–127. https://doi.org/10.1016/j.lindif.2007.07.004.
Zhu, C., Valcke, M., & Schellens, T. (2008b). The relationship between epistemological beliefs, learning conceptions, and approaches to study: A cross-cultural structural model? *Asia Pacific Journal of Education, 28*(4), 411–423. https://doi.org/10.1016/j.lindif.2007.07.004.

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The Creative Learning Spiral: Designing Environments for Flaring and Focusing

Jane Zhang

Abstract With growing interest in creative learning in recent years, this paper sought to define creative learning through the design of learning spaces. Two learner groups were studied for their interactions with peers, educators, and their spaces—design students at Harvard's Graduate School of Design, a traditional architectural studio environment, and student entrepreneurs at the Harvard Innovation Lab, a startup venture incubator. The result was a new design framework called the creative learning spiral, which groups creative learning into four types of activities: *sparking, making, grazing, socializing*. The open layouts of both settings facilitated social learning activities of *sparking, grazing,* and *socializing*, whereas *making* time required students to create their own focused environments. The creative learning spiral can be used as a tool to assess the spatial needs of specific creative learning activities, in order to design environments that accommodate the needs of learners.

Introduction

In the context of a rapidly evolving knowledge economy, creativity has become one of the most highly regarded qualities of a twenty-first-century graduate, across age levels. Tony Wagner defines creativity in terms of curiosity and imagination (Wagner & Compton, 2015). Jal Mehta and Sarah Fine, pioneers of the Deeper Learning movement, observe that "on the professional front," students "need to be able to tackle open-ended problems in critical, creative, and collaborative ways" (Mehta & Fine, 2015).

Research on the theory and practice of creative learning has stemmed primarily from the fields of psychology and education. In the former, the field of creativity was long studied using the level approach, focusing on "understanding, predicting, and nurturing people's ability to produce novel ideas, solutions and products that served some need" (Puccio & Chimento, 2001). In 1976, Kirton introduced a departure from this method, proposing "a cognitive style continuum that ranges from an adaptive to

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an innovative orientation [where] location along this continuum indicates the extent to which an individual will exhibit either a more adaptive or more innovative style of creativity" (Puccio & Chimento, 2001).

Within K-12 education research, the act of creation has been central to definitions of creative learning. Mehta and Fine (2015) see creativity as capturing "the shift from receiving the accumulated knowledge of a subject or domain to being able to *act* or *make* something within the field." Mitchell Resnick of the Lifelong Kindergarten group at the MIT Media Lab sees creative learning as a culmination of four Ps: project, peers, passion, and play (Schmidt, Resnick, & Ito, 2016). Architect Saeed Arida founded NuVu Studio, an innovation school for middle and high school students, to concretize the need to develop both *seeing* and *doing* in students. According to Arida, the creative process combines mindfulness with doing and is fundamentally social (Arida, 2010).

This chapter aims to reframe these previous conceptions of creativity through a spatial design perspective. How might creative learning be understood through the learner's use of space? Arguably, creative learning in the twenty-first century both requires and allows the physical learning environment to act as a teacher in facilitating learning. The creative learning spiral—a theoretical framework combining four modes of learning—is developed through the understanding of a learner's postures in space, and how one engages with people and objects in the learning process.

Methodology

The creative learning spiral was developed out of studying two learner groups: designers at the Harvard Graduate School of Design (GSD), and entrepreneurs the Harvard Innovation Lab (i-lab). Within the author's campus environment at Harvard University, these sites were chosen for their relatively high concentrations of two types of creative work. The GSD exemplifies a traditional architectural studio environment, where students are tasked with projects to produce a variety of 2D and 3D models of space. The i-lab represents an increasingly popular typology on college campuses—the startup incubator, where students are provided a dedicated environment with resources to start and develop viable ventures.

The Harvard Graduate School of Design is one of the oldest design schools in the country. Architecture courses were first taught at Harvard University in 1874, and the GSD was officially established in 1936, combining three fields of architecture, urban planning, and landscape architecture. Today, its programmes also include urban design, design studies, real estate, and design engineering.

The primary pedagogy of the GSD is the architectural design studio—a project-based learning model and environment in which "designers express and explore ideas, generate and evaluate alternatives, and ultimately make decisions and take action" (Gross & Do, 1997). The GSD studio model is based off of mid-century Bauhaus workshop pedagogy, which builds upon "modern-era teaching methods [that] ranged from lecture courses to workshops where students would learn how to build from the day they stepped into the workshop" (Lueth, 2008). The design studio focuses on hands-on, interactive, and integrative learning, all of which take place in the studio. Austerlitz, Aravot, and Ben-Ze'ev (2002) outlined four characteristics of the modern-day design studio, one of which was the personalized design process, which implies creativity, and the space for a student to lay out his or her ideas in the open.

Gund Hall, which opened its doors in 1972, was designed by Australian architect and GSD graduate John Andrews. Its primary feature is the collective studio space that extends five levels under a stepped, clear-span roof with natural lighting and views towards Boston. The central studio space is enveloped with a band of classrooms and offices on every floor. The main floor is home to a rotating public exhibition space, the Loeb library, and Piper Auditorium. The basement holds the stacks of Loeb library and the fabrication labs.

This portion of the study employed the ethnographic method of participatory observation of the studio learning over the course of one academic year. The author attended GSD classes and seminars, interacting daily with peer design students in the studio space (Fig. 1).

The second portion of the study explored student use of the Harvard Innovation Lab, an incubator for student-led startup companies, across Harvard's College and graduate schools. The i-lab occupies most of the ground floor of Batten Hall on the campus of Harvard Business School (HBS). Before it opened its doors as part of HBS in 2011, the building was previously home to WGBH's TV and radio studios. The i-lab serves as a resource to foster collaboration and incubate ideas among Harvard

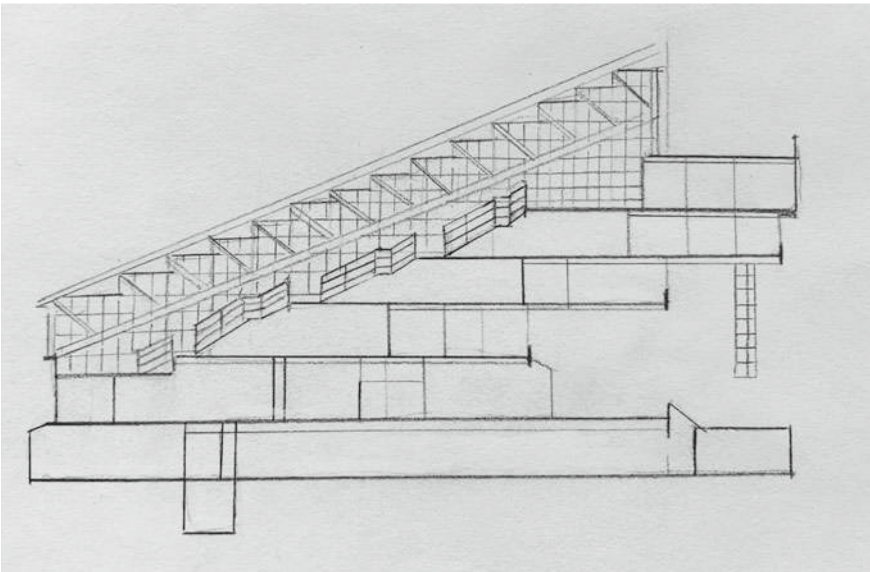

Fig. 1 Gund Hall section drawing showing the open air, tiered studio space

Fig. 2 Axonometric 3D model of the first floor of Batten Hall, showing the Harvard Innovation Lab space. *Source* Shepley Bulfinch (with permissions from Shepley Bulfinch)

students, faculty entrepreneurs, and members of the greater Boston communities through regular programming.

A random sampling of 21 students (out of 66 teams) was surveyed for their use of the space in relation to creativity, focus, and general productivity. Students elected to participate in the study by responding to a survey link sent through an internal Facebook group, and students completed it anonymously over the span of one week. A survey was used to scale up the observational methods used at the GSD, in order to capture a larger breadth of responses (Fig. 2).

Survey questions were designed to elicit user feedback about productivity, creativity, and general use of the incubator workspace. The following consist of a combination of quantitative and qualitative questions:

- What do you like most about the space at i-lab?
- What % of the time do you feel creative here? (e.g. generating wild ideas)
- Where does that happen and what are you doing?
- What % of the time are you able to focus here?
- Where does that happen and what are you doing?
- Where in the i-lab do you feel most productive? Why?
- When do you feel most productive here? What are you doing in these moments?
- Where outside of the i-lab do you like to work? What do you like about it there?
- If you could change one or two things about the i-lab space, what would it be?

A combination of open-ended and closed-ended questions was used to achieve depth and breadth in student responses. Students were asked to identify the percentage of the time they felt creative and focused on the space, and where and when they felt most productive in the space. These responses provided a quantitative baseline to form a community profile, and were coupled with more open-ended questions for students to discuss their specific pain points, preferences, and suggestions for the space. Textual analysis was run on the open-ended answers to determine the most popular keywords and sentiments for each question, from which specific responses were examined to build user profiles.

Findings

Graduate School of Design: The GSD study resulted in four steps of the studio learning process, each tied to a specific space typology.

Lecture Hall

The creative process for each studio course begins with *sparking*, or inspiration, from an expert figure. This mainly takes the form of lectures and guest talks, where a design luminary provides both context for a project and design direction (Fig. 3).

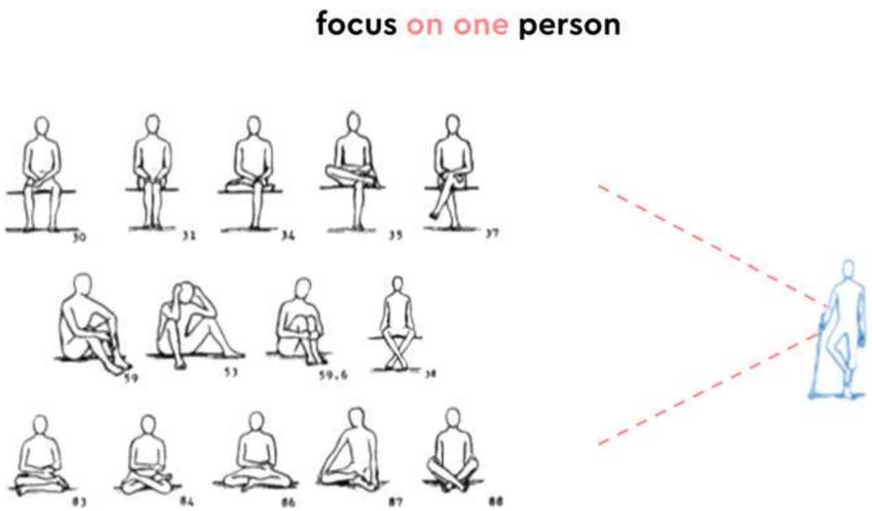

Fig. 3 Illustration showing the process of sparking, or inspiration, in a lecture-based setting

Site Visits

Once students are sparked with theory and background information, they conduct site visits to better understand the context in person. These visits are guided and framed by design professionals in the field, often policymakers or clients who provide the design brief and project constraints. This phase represents intensive information-gathering—taking lots of notes and pictures—that students will later sift through back in studio.

Studio

The studio area takes up the majority of the square footage in Gund Hall, aptly corresponding to the amount of time students spend in this space. Design students are notorious for living "in-studio," spending up to 80 hours a week at their desks, working on drawings, models, and socializing with studio-mates. Many students spend their entire days and evenings here, leaving only for classes and sleep, especially during final review season (Fig. 4).

Each student enrolled in a studio course receives a semi-private desk area, with a 30" × 70" table space. The open-air studio is combined with frosted plexiglass

Fig. 4 Gund Hall studio space at peak occupation. *Source* Hayoung Hwang, The Harvard Crimson (with permissions from The Harvard Crimson)

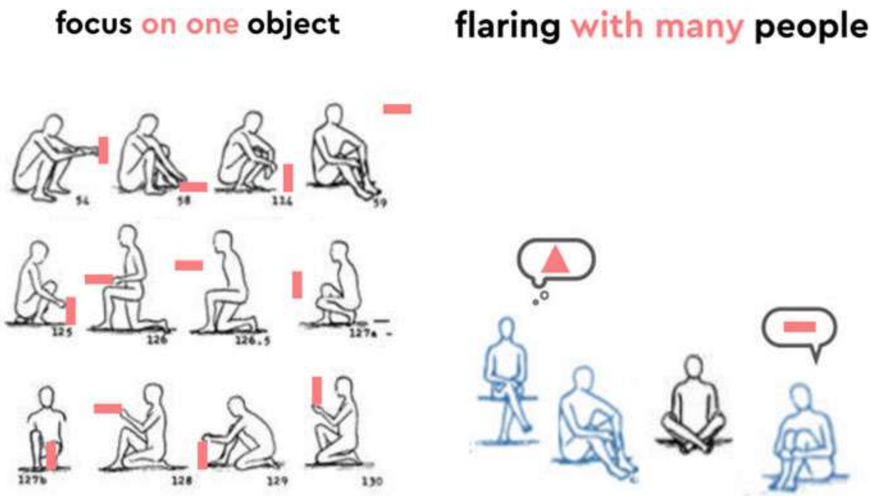

Fig. 5 Illustrations showing the phases of making and socializing, where students engage with their work individually and with peers

dividers between studio desks, making for semi-private workspaces. Depending on where one sits in this five-floor studio, one may hear the din of conversation in the cafeteria downstairs, printers and plotters whirring at the ends of each floor, and people walking through on their way to classes. To indicate focus, students plug in headphones and listen to music, podcasts, or watch TV as they work.

Throughout the semester, students have multiple opportunities to showcase their work and receive feedback: peer feedback between students in studio; desk crits, i.e. one-on-one meetings with faculty at student desks; pin-up sessions where students pin up their work for faculty to critique (Fig. 5).

Studio Review

The studio process culminates in a final review, where each student is allotted time to present his or her work to an esteemed panel, and receives feedback. At the end of each semester, Gund Hall transforms from museum to theatre mode as final review season dawns. Virtually all desk, floor, and classroom space becomes occupied by all kinds of materials and forms. The final review, or critique, is the telos of the design studio—where all efforts culminate in a single performance. The student carefully prepares drawings on boards, models on pedestals, and presents the project to a panel of design luminaries and studio-mates. The space is set up with the presenter's work as the focal point and the presenter defending the particular design proposal; surrounded by a panel of experts who ask pointed questions and examine the models

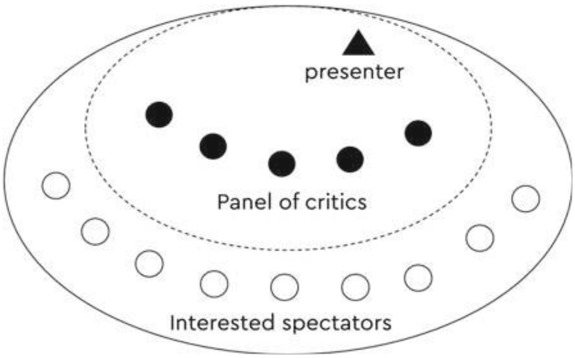

Fig. 6 A diagram depicting the spatial hierarchy of participants in a final review setting

and drawings at their leisure; and an outer halo of interested observers, mainly other students (Fig. 6).

Harvard Innovation Lab

The findings from the second portion of the study revealed insights about the effectiveness of an open layout for productivity, in terms of both creativity (generating original ideas) and focus (heads-down work time) (Fig. 7).

Based on textual analysis, the most frequent responses to the question “What do you like most about the space at the i-lab?” were the variety of *seating* options, conference *rooms*, access to *people*, *open* layout for ease of communication, and *flexibility* of furniture. Users felt creative in the space 38% of the time, and typically that would occur during brainstorming sessions or team meetings, where ideas were being exchanged, particularly through the use of a whiteboard. Overall, users were able to focus 68% of the time. The biggest keyword around productivity was *headphones*, followed by working on a *computer*, *plugged* in, and sitting at a *desk*. Drilling down further, users felt most productive in meeting *rooms*, followed by *open* workspaces.

For those that spent all day in the incubator, early mornings and evenings tended to be the best times for productivity, as these times were quiet, with the least distractions. Mid-day brought peak noise hours, and almost all respondents dealt with noise by plugging in headphones or working in private meeting rooms.

When asked what they would change about the space, top suggestions were “desks,” “warmer,” and “space,” suggesting ergonomic improvements, temperature comfort, and optimizing space use with the overall layout.

A few users were extremely satisfied with the space, reporting high rates of creativity and focus. One user, who experienced 90% creativity and 95% focus (90/95), liked many attributes of the space: “the lighting, the different opportunities to interact with the great people there (food space/events, table tennis area), the possibility to use silence private rooms when needed, the business talks.” They found

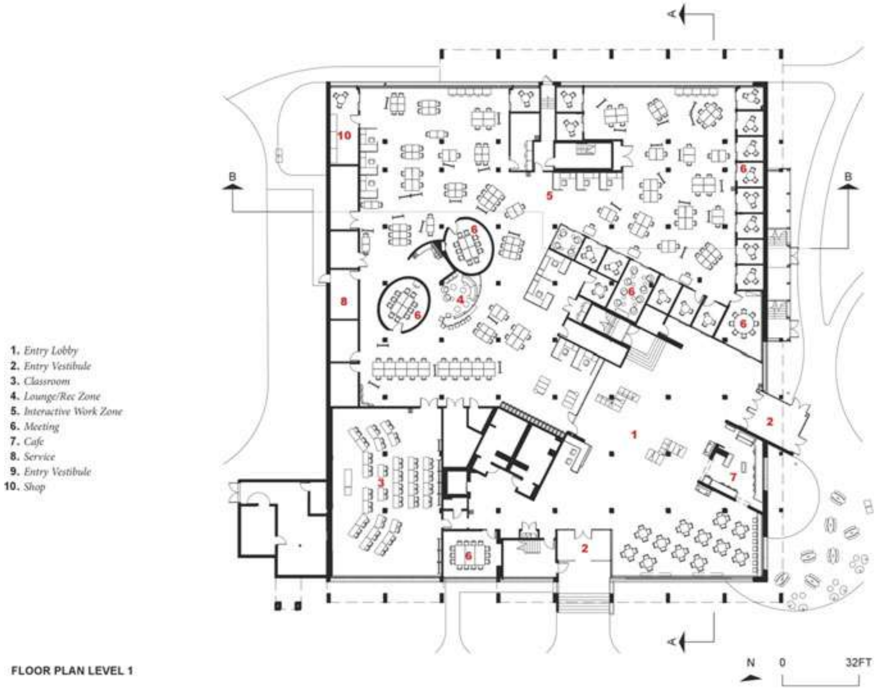

Fig. 7 Plan view of the i-lab incubator space. *Source* Shepley Bulfinch (with permissions from Shepley Bulfinch)

no particular productivity patterns, and felt productive in both the open and private spaces. One user would only go into the i-lab to work, which usually looked like brainstorming in a room, and thus reported 100% creativity and productivity in the space.

The majority of users (86%) felt productive more of the time than creative. One user cited 10% creativity and 90% productivity, primarily because of the stage they were at with their company: "I'm pretty far along with ideation of my company, so everything now is execution. Early on I had far more wild ideas during conversation with others."

Only three users felt creative more of the time than productive in the space. One user, a 60/30, felt creative "in the [open] area with rolling whiteboards, in rooms with whiteboard walls, [and while] synergizing with other teams." They found the most productivity while in a lounge chair with headphones in.

A few users did not find the space particularly creative or productive. One user (20/40) saw the i-lab mainly as "a place to go to work every day and feel accountable to myself." This user felt creative at random times, "while [they were] sitting around and talking to people" and felt productive when "sitting far away from people with my headphones in."

Among other insights, the data indicates that the i-lab's open layout works well for spontaneous meetings, socializing, and peer feedback. However, for the majority of *making,* or heads-down work time needed for entrepreneurial projects, the open layout—and the distractions it produced—sometimes posed a hindrance to productivity.

Results

According to Amy Webb (2017), conflicts often arise in teams or organizations due to the "duality dilemma"—the clash between people whose dominant characteristic is either creativity or logic. Webb says this is responsible for a lack of forward thinking at many organizations. An effective way that she proposes to overcome this duality is to "harness both strengths in equal measure by alternately broadening ("flaring") and narrowing ("focusing") its thinking" (Webb, 2017). The idea is to facilitate a co-working process whereby both generative, creative thinking as well as analytical, logical thinking are rewarded. With creative learning, a similar sequence of generative and logical modalities is needed.

One key pattern arising from the space use logic at both the GSD and the i-lab is the presence of both flaring and focusing as key activities of creative learning. Among these activities, the learner either focuses or flares on people or objects. As such, the following creative learning spiral was observed:

The spiral begins with *sparking*, or focusing on one person. These bouts of inspiration come from the setting of a lecture, talk, or a private meeting with some expert or mentor figure. Next, in the *making* phase, the learner focuses on objects with heads-down tinkering and work time. Third, the learner enters a research phase of *grazing* on different materials and objects, from precedent projects to research papers to field visits. Fourth, the learner socializes with his or her peers, giving and receiving feedback to discuss ideas and refine their projects. The spiral closes with a phase of *reverse sparking*, where the learner demonstrates his or her learning through performing or showcasing the project. At this phase, the learner receives critical feedback from mentors and experts, and the aim is for this feedback to funnel into future work. This process is not linear—learners can go back and forth between phases during the creative learning process. Moreover, creative learning is iterative—hence a continuous spiral (Fig. 8).

This spiral is designed to act as a framework for both designing and assessing learning environments for creative work. For educators and institutions looking to move towards student-driven, hands-on project-based learning, these four learning modalities and postures can serve as a launch pad for learning space and curriculum design.

Key questions in designing a learning environment include:

– What does this type of learning look like (i.e. human postures and activities)?

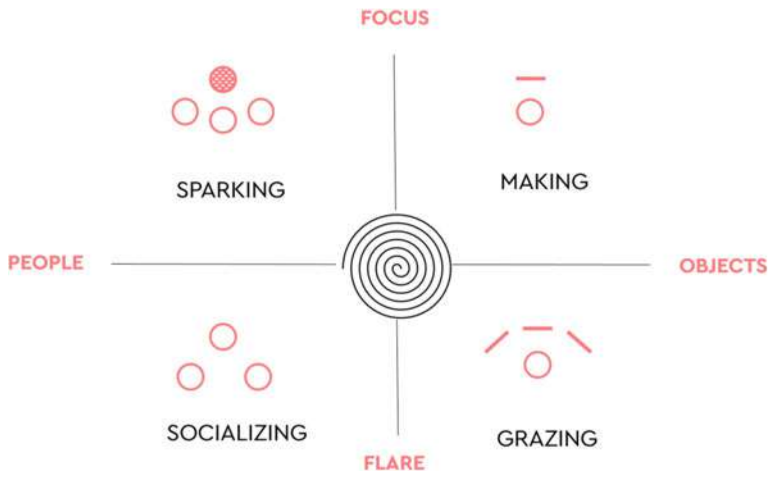

Fig. 8 The creative learning spiral, depicting four modes of learning: sparking, making, grazing, and socializing

– How might we effectively provide learners with access to the people, materials, and resources needed for this specific project?
– What pedagogical tools (including spaces) need to be considered?
– What measures of learning do you hope to enhance in this learning environment?

Discussion

Much of the existing literature on creative learning focuses on the learner's personality, or interactions with educational material and other people. Often, the environment in which this learning takes place is overlooked, yet it can have a significant impact on the learning experience. This chapter explored the potential for a creative learning framework defined through the space. Through participatory observation, quantitative and textual analysis of user feedback, this study produced four related outcomes.

First, the creative learning activities observed at the GSD and the i-lab both support a strong connection between space types and the learning modalities. As the images below illustrate, each space type accommodates one or several learning modalities in the creative learning spiral. Lectures at the GSD and office hours with mentors at the i-lab accommodate *sparking*, where students engage with new ideas from experienced advisors. The open studio or workplace facilitates both *making* and *socializing*—students work heads-down work and tinkering, while having easy access to peers for collaboration and feedback. Site visits, and sometimes the work environment itself, provide fodder for *grazing*, researching, and engaging with project precedents. In many instances, *grazing* may involve more digital than physical artefacts, such as in the case of having many tabs open on one's web browser (Figs. 9, 10, 11, 12, and 13).

Secondly, while the four modalities and their accompanying spaces may all be integral to the creative learning process, the i-lab study in particular showed that not all these activities merit equal time or attention. The i-lab users cited feeling creative 38% of the time and focused 68% of the time, yet the majority of critiques reflected

Fig. 9 The sparking stage involves bouts of inspiration from experienced advisors, which can take place in settings such as lecture halls and office hours

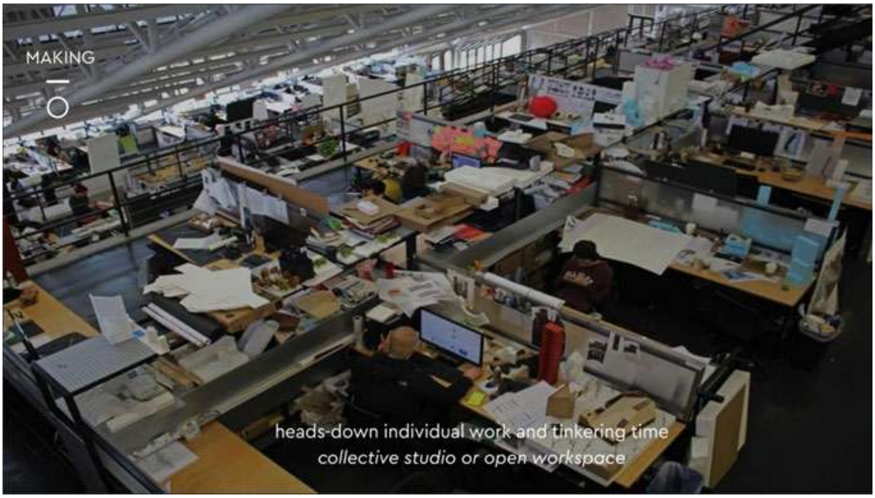

Fig. 10 The making stage consists of heads-down individual work and tinkering time, shown here in a collective studio and open workspace

Fig. 11 The grazing process involves researching and engaging with a project's precedents. This can include library research, field research, or desk research in-studio

Fig. 12 Socializing one's work involves giving and receiving feedback from peers. Ideal environments include in a collective studio, breakout rooms, or semi-private spaces

a need for *more* focus time. In fact, the square footage of the i-lab is roughly 25% closed rooms and 75% open layout (Fig. 6). As such, the space privileges more social learning activities—*sparking, socializing, and grazing*. The space was successful at facilitating social connections, though acoustic openness may not have served student needs in *making*.

Fig. 13 The creative learning spiral redrawn to reflect heads-down making time making up the majority of the learning process

In the case of both the i-lab and GSD, one might redraw the creative learning spiral into the following pie chart diagram, depicting time spent on various activities. Heads-down *making* may consist of about 80% of the creative learning process, whereas the other activities make up just 20% of the time.

This 80/20 ratio is simply an estimate by the author based on the aforementioned observations, surveys, and interviews. The numbers could be validated in accuracy and precision by ensuring that the observational and survey methods were employed equally in both sides. In addition, sensors could be used to measure occupancy and flow in the spaces, expand data collection capabilities to real-time, 24/7 inputs. These inputs could complement the participatory observation, which surfaces qualitative details from users.

Thirdly, while learning environments are shown to facilitate or hinder certain activities, space constraints are not decisive of learning or productivity. Both Gund Hall and the i-lab were designed with *sparking, socializing, and grazing* activities in mind, with ample space for interaction and connection among students, and between students and mentors. However, in both environments, students ended up spending the majority of the time in *making* mode, which based on survey responses, requires some acoustic privacy and/or distance from distractions.

In both the GSD and i-lab open-air environments, students compensated for acoustic distractions by plugging in headphones. From a design research perspective, headphones can be read as a coping mechanism, or adaptation to one's environment to achieve productivity. In other words, there is a need in these environments for semi-private workspaces, particularly for acoustics. The designer of a creative learning space such as an open studio or open workspace, then, is encouraged to generate design solutions that not only allow for social learning activities, but also serve the large need for heads-down focus time. Such solutions might look like semi-private booths, pods, acoustic panelling, partial barriers, among other things. Ultimately, the goal would be to achieve the right balance of focus and creativity needed for creative learning.

Fourth and lastly, design of a particular learning environment ought to account for the needs of its particular user population, and more importantly the curriculum or pedagogy the environment is designed to facilitate. When designing or renovating a learning environment for creative activities, one might employ the creative learning spiral as a framework to plan and lay out the space. In addition to basic architectural questions such as safety, daylighting, flow, etc., spatial design questions related to the learning process include:

– What activities will learners and educators engage in? How do they fit into the categories sparking, making, grazing, and socializing?
– How much time will learners spend in each activity type?
– Which activities and programme elements require special spaces and/or equipment?
– What is the noise level of each activity type?

Answering these questions may provide a useful framework for the ratios among different space types, adjacencies, and acoustics. While the particular application will look different based on context, the creative learning spiral may be a valuable tool to connect the dots between pedagogy and space, leading to user-friendly environments for creative learning activities.

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References

Arida, S. S. A. (2010). *More seeing in learning* (Doctoral dissertation, Massachusetts Institute of Technology).

Austerlitz, N., Aravot, I., & Ben-Ze'ev, A. (2002). Emotional phenomena and the student–instructor relationships. *Landscape and Urban Planning*, *60*(2), 105–115.

Gross, M. D., & Do, E. Y. (1997). The design studio approach: Learning design in architecture education. In J. Kolodner & M. Guzdial. *Design Education Workshop* (Eds.), EduTech/NSF, College of Computing, Georgia Institute of Technology, 213 September 8–9. Atlanta.

Lueth, P. L. O. (2008). The architectural design studio as a learning environment: a qualitative exploration of architecture design student learning experiences in design studios from first-through fourth-year.

Mehta, J., & Fine, S. (2015). The why, what, where, and how of deeper learning in American secondary schools. *Students at the Center, Deeper Learning Research Series.* Boston, MA: Jobs for the Future.

Puccio, G. J., & Chimento, M. D. (2001). Implicit theories of creativity: Laypersons' perceptions of the creativity of adaptors and innovators. *Perceptual and Motor Skills*, *92*(3), 675–681. Retrieved from: http://journals.sagepub.com/doi/abs/10.2466/pms.2001.92.3.675.

Schmidt, J. P., Resnick, M., & Ito, J. (2016). Creative learning and the future of Work. *Disrupting Unemployment*, 147–155.

Wagner, T., & Compton, R. A. (2015). *Creating innovators: The making of young people who will change the world.* Simon and Schuster. Retrieved from: https://www.researchgate.net/profile/David_Nordfors/publication/301233086_Disrupting_Unemployment/links/57463c0808ae9ace84243998.pdf#page=155.

Webb, A. (2017). The flare and focus of successful futurists. *MIT Sloan Management Review*, *58*(4), 55–58. Retrieved from: https://search.proquest.com/openview/27d54ad979f5570e021651c1b5f9bd70/1?pq-origsite=gscholar&cbl=26142.

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Teacher Practices

Introduction to Part IV: Teacher Practices

Wesley Imms and Kenn Fisher

Abstract This final section of Transitions focuses on arguably the most important element of 'successful' ILEs—the teacher. Within educational research alone, and when looking at a hundred years or more of research into quality schooling, most arguments attract a counter-perspective. Interestingly, on one factor virtually everyone agrees; the teacher has the greatest positive impact on the quality of student learning. For this reason, we use the preceding sections to lead us into discussions about how teachers occupy and use the educational space.

This section of Transitions purposefully comes as the final section of this book; it brings the previous conversations together using as the focus, the critical factor of *the instructor*. Teacher practices lie at the heart of the ILETC project; this is because the evidence from years of educational research show that their actions have the most direct effect on improving the quality of student learning. This book makes the case that good use of ILEs can make good teaching even better. The four chapters scoped below explore this concept in some depth, separately and forensically examining: how the 'we' and the 'I' can be integrated into the ILE; how teachers in training can be inducted into the concept; how two distinct disciplinary pedagogical approaches can be supported by ILEs and finally how often inflexible state imposed regulations can be 'hacked' to insert ILE prototypes to illustrate alternatives to the mandated rigid traditional classroom model. These present explicit examples of a more general issue—deconstruction of decades of practice that has largely ignored the physical. These selected chapters show that the issues to be addressed take on a myriad of forms, and that there is no one 'big mistake' to fix and therefore no one solution.

Vicky Leighton's chapter signposts the beginning of a challenging journey, one that continues excellent thinking from previous generations but remains unresolved. It concerns the very essence of a teacher's inhabitation of an ILE—their

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so-called ‘spatial competency’. Lackney and others emersed themselves in this concept decades ago, and Leighton revisits their work with an eye to the 2020s. She extends this thinking using cognitive psychology and ecological psychology theories to reconceptualise the concept as ‘situational environmental imagination’. This well-considered positioning places Leighton on the cusp of major advancements in our understanding of how teachers use ILEs. The chapter represents the theoretical framework for a PhD that has, since writing this text, further problematised teachers’ abilities to ‘use’ a space and has used that foundation to design methods to ‘observe’ and understand these skills in action in classrooms.

Anat Mor-Avi, a practising architect and artist, embraces the ‘spirit of we’ in ILE’s, where ‘we learn’. The school should be a space for both students and teachers to ‘become’. Having designed schools in both the USA and Israel, she has brought her artistic thinking to the built fabric in—perhaps—modelling school on the Kibbutz concept. This concept clearly balances the ‘we’ with the ‘I’, as Mor-Avi uses as a case study an ‘academic park’ being designed in Israel. As an artist, she also focusses on creative pedagogies and spaces that support this approach. In particular she adopts the concept of ‘participatory creativity’, surely a significantly relevant teacher-learner practice in this age of the entrepreneur, incubator, startup and pop-up culture our graduating school students will experience. This chapter is an aspirational and inspirational vision for progressive teacher practice and transition to ILE’s.

Emily Nelson and Leigh Johnson tackle the pre-service teaching undergraduate programs and the perceived barriers to transition to ILE’s in New Zealand. They view ILE’s through the lens of socio-spatial entanglements for practice. They point out ‘the reality that approximately 75% of teaching and learning in schools continues within single cell learning spaces with teacher-led pedagogies’. This would also be true in Australia’s existing school building stock, and most probably in most countries across the world to varying degrees. With the advent of pressure to transition to ILE’s, they liken this disruption as an entanglement. In unpacking this, they adopt concepts from Lefebvre (1991) and Monahan (2002) to focus on spatial consciousness/discourse, embodiment and materiality. Through focus groups with pre-service teacher trainees, the authors grapple with ‘messy materiality’ and offer a rich array of ethnographic comments as to how these adult students learn the teaching profession in practicums. They argue for a ‘head-on’ engagement with ‘material disruption’ and ‘messy materialities’, as these trainees ‘generate adaptive practices in these spaces for practicum’.

Silvia Sasot and Esther Belvis take a zeitgeist approach to transformation and transition exploring opportunities through ‘hacking the school’. They worked towards a school transformative toolkit using emergent principles which included: welcome, belonging, communication, cooperation, diversity, movement and transduction. These principles afford a dialogic space between teachers, administrators and designers to ‘disrupt’ the out-of-date regulatory environment in Spain. Their approach also sought to consider wellbeing, pedagogy and community along with engagement with the stakeholders. This was achieved through prototype micro-projects sponsored by the JF Foundation, where schools were invited to ‘pitch’ their ‘hack’ of traditional spaces to secure funding for these exemplars. The toolkit was used to assist this process of design through four stages: starting, discovery, co-creation and assessment. The authors assert that some 30 schools were able to 'hack their schools' and work around the regulatory framework and in so doing form a community of practice for future project developments.

An architect and artist speak of creative and affective school pedagogies; two academics learn from their students' learning; an artist/teacher and an architect collaborate on deconstruction and reconstruction of spaces; this is the currency of knowledge generation typical of our new age of professionals working on re-deigning teaching in innovative learning spaces. These chapters illustrate the array, complexity and challenges of systematic spatial school rebirth across international borders, disciplines and professions. In many ways, they typify ILETCs evolving methodology.

References

Lefebvre, H. (1991). *The production of space*. Oxford: Blackwell Publishing.

Monahan, T. (2002). Flexible space & built pedagogy: Emerging IT embodiments. *Inventio, 4*(1), 1–19.

Wesley Imms (Australia) comes to learning environments research from a long period as a teacher, then through a Ph.D. in Curriculum Studies from the University of British Columbia in Canada. His teaching spanned art and design education, his practice for decades has included designing and building 'crafted' homes, and his art works have focused on bespoke purposeful furniture construction, which he exhibits annually. For the last decade these interests have conflated into applied research programs, where he specialises in assisting schools to conceptualise, inhabit, refine and evaluate learning environments. This work has focused extensively on large-scale collaborative projects that draw heavily on international industry participation, and with an emphasis on Ph.D. and Masters level input to this knowledge generation. He is a co-Director of the LEaRN group, manages LEaRN@MGSE, and through selected consultancies he works closely with schools in the Asia-Pacific region on improving the use of innovative learning environments. Wesley is currently an Associate Professor at The University of Melbourne, Australia.

Kenn Fisher (Australia) is recognised as one of the leading learning environment specialists practising locally, nationally and internationally for over three decades. He has practised in Australia, Asia, the Middle East and Europe as a consultant to the OECD (where he held the post of Head of the Program on Educational Building in Paris in 1997/8) and UNESCO. He is multi-skilled in a range of disciplines having practiced in all education sectors as a teacher and academic, a strategic facility and campus planner and as a project, facility and design manager. He has been engaged by more than 30 universities world-wide, over a dozen vocational training and community college clients, a number of State and National Government Ministries of Education, many school organisations and Government and corporate entities. Kenn is currently an Associate Professor in Learning Environments at The University of Melbourne's School of Design (MSD).

Envisaging Teacher Spatial Competency Through the Lenses of Situated Cognition and Personal Imagination to Reposition It as a Professional Classroom Practice Skill

Vicky Leighton

Abstract This chapter examines the complex phenomenon of teachers' spatial interactions in their learning environments. Its goal is to examine concepts and theories that might inform a working conceptual framework. Building on recent studies that question how school environments can influence teacher behaviour, spatial concepts as well as architectural and cognitive psychology theories are examined to explore the dynamic and mutually dependent relationship between teachers and learning spaces. A new concept of 'situated environmental imagination' is devised as a conceptual explanation for teacher spatial competency; it also provides practitioners with the means to evaluate and observe space-related skills in classroom action settings. This approach pursues a non-linear understanding and analysis of space and teacher practice that blends architectural and educational perspectives, resulting in an argument for the inclusion of spatial competency as an important professional skill that has the potential to enhance student learning.

Preface

In setting up a theoretical conceptual framework in which to explore a teacher's spatial competency, it has become necessary to understand the relationship between the built environment and human behaviour. The environment is acknowledged by many teachers as one minor element of a battery of tools to educate others, however, it is seldom placed front and centre when considering the transaction between teaching and learning. But it should be. Across the globe, school environments are the focus of government policy and the recipients of systematic, significant investment. This has evolved as a strategic response to narratives that are recasting what effective teaching and learning should be for post twentieth-century work and education (Byers, Mahat, Liu, Knock, & Imms, 2018; New Zealand Ministry of Education,

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2014; OECD, 2013). Significant public funding in new school buildings has been invested to promote teaching and learning that is characterised by critical thinking, collaboration, problem-solving, communication and creativity. Beyond these investment programmes, it is recognised that most teachers are situated in a classroom, new or otherwise, which remains the key environment in which instructional learning is conducted. These teachers interact with their classroom space both consciously and unconsciously. They are taught how to teach curriculum content and pedagogy, however, until very recently they are rarely trained on how to use space to advance and support their teaching and maximise learning experiences for students.

Through an exploration of historical behavioural sciences, ecological psychology and the more recent emergence of cognitive psychology supported by neuroscience, this chapter argues that a teacher's behaviour within a classroom 'action' setting is a mediated 'imaginative' response between their real-time, 'situated' interaction with the environment itself, and the social world. This behavioural response can be recognised as a part of a teacher's professional practice and as a teaching skill.

This reimagining of the roles played by both people and the built educational space challenges educators and designers to investigate in-depth what already occurs in traditional or established classrooms and to consider the impact of teacher situated cognitions on these and innovative learning environments. Where sequences and patterns of behaviour are encouraged by the built environment and are consciously or unconsciously acknowledged, these in themselves become the experiences of educational places that feed an individual's professional practice. They shape a teacher's spatial behaviour which in turn has a direct impact on student learning.

The impact of this idea is manifold. It suggests that educational settings are places that shape what people do, how they engage with one another and how they consequently contribute to the construction and deconstruction of teacher identities. It implies that the built environment (the classroom), which provides a framework for behaviour, allows for a future that can be purposefully constructed and manipulated, acknowledging that the contextualised environment itself is also shaped through this interchange. It invites exploration into the connections between student learning and teacher spatial skills and engagement. It suggests that teachers can be taught to hone their spatial practices to enhance learning through training and intervention, recognising that all teachers possess spatial skills. This approach puts the impact of a teacher's spatial professional practice squarely in the centre of the learning and environment debate.

What follows is a brief synopsis of key cognitive concepts and theories that are examined to conceptualise teacher spatial competency (TSC). These are used as a source of insight rather than empirical study. It is acknowledged that a range of deliberate parameters has been imposed; rather than an in-depth exposition of architectural design or cognition theories, a range of general agreements from these areas of human science are accepted and a lens of educational professional practice applied. This has enabled a conceptualisation of the phenomenon known as teacher spatial competency and provided a framework for research.

Introduction

Although systematic studies examining how school architecture informs teaching and learning are rare (Byers, Imms, & Wheaton, 2015; Higgins, Hall, Wall, Woolner, & McCaughey, 2005), research focused on learning spaces is gaining momentum. Fine-grained studies examining learning and learning environments such as these are finding evidence that suggests these two educational components share a binary relationship that somehow incorporates elements of duality and dichotomy. They argue that teachers and learners occupy designed educational spaces that do inevitably influence the teaching and learning cycle, and that this relationship is complex and not always articulated or understood. This leads to key questions for educators and architects which centres on what spatial knowledge or skills teachers need to successfully utilise traditional or innovative learning environments to positively impact learning outcomes. It seems clear that a blend of architectural, educational and social theory is necessary to understand, describe and interpret the complex concepts at play, and to develop a conceptual framework to underpin teacher spatial competency research. Furthermore, clarity is required around the definition of the key term 'TSC'. For this research, it is proposed that a spatially competent teacher is a teacher that deliberately and purposefully utilises (through their professional practice) the attributes of a classroom and surrounding environment (in their 'place') to deliver specific pedagogical goals. As learning goals change (these are highly responsive to context), the teacher also changes the utilisation of the space to enhance student learning experiences (this a result of their thought processes). This chapter will examine the three key elements, teacher place, practice and thinking, embedded in this broad definition.

Teacher Place

The study of human behaviour gives us an insight into understanding human activities, attitudes and values. When it is accepted that the environment has an impact on human behaviour, this allows for the theorisation of human spatial interactions through a range of cognitive processes including motivation, perception, cognition and affect. Differentiating between the actual, real or objective world and the phenomenological world that is perceived either consciously or unconsciously also offers the potential for new conceptual frameworks to understand and observe how humans are impacted by places and space.

Architecture and Phenomenology

Although this is not a phenomenological argument, some of the principles associated with its approach to qualitative research apply to the exploration of teachers' spatial perspectives and competency. The relevance of a phenomenological approach is also acknowledged when considering the philosophical roots from which it arises (Moustakas, 1994). Phenomenologists seek to develop direct explications of ordinary life and human experience. These experiences often go unnoticed as they are so embedded in our way of living and thinking and are unique to each person. To borrow from Pointon and Kershner (2000):

> Further, at a perceptual level, it has to be recognised that it is hard to understand another person's experience of the environment, even if one can measure certain objective features. As Howe (1984) remarks, 'each person's experiences of an environment are unique and constantly subject to variation, largely because people learn from their own experiences. Many factors connected with individual development and learning, including perceptual sensitivity, personality and temperament, combine to ensure that however uniform an environment might appear to be, people's actual experiences differ very considerably' (p. 96).

Architecture phenomenological research emphasises and interprets the lived, human experience of everyday buildings in everyday lives. That is a corporeal or bodily engagement with space expressed via human action in synchronisation with the physical environment. The two elements, in this case teacher and learning environments, 'interanimate each other' (Casey, 2009), providing a tantalising inference of potential impact on teacher practice and student learning. If a teacher is 'interanimated' by their learning environment, this implies that the interaction can be positively manipulated to impact student learning.

Several academics take this perspective further. Oblinger (2006) theorises that learning spaces arbitrate social and relational teaching with learning conventions and builds an argument that this mediation is only one factor in a complex range of contextual variables that inform learning outcomes. These factors include, but are not limited to, school context, culture and profile, pedagogies, curriculum, technologies, learning environment and aesthetics, as well as community members themselves. A study of Lefebvre suggests this mediation is social interaction (1991). It is argued that teacher spatial experience is, therefore, a lived dynamic where there is a reciprocal engagement with the environment. This is significant at it suggests these contextual interactions influence a teacher's professional practice. It can be concluded that occupiers and space are mutually dependent and ever-evolving.

Architectural Vocabularies and Literacies

Researchers have wrestled with this dynamic relationship. Fisher questions why teachers appear to ignore their learning environments as a pedagogical tool, arguing that 'it is in the school campus that we all begin to learn how architecture is lived and experienced and develop our architectural vocabularies and spatial literacies' (Fisher, 2004, p. 37). Fisher's observation underpins the focus of this chapter which, assuming improved student learning is the educator's goal, argues that physical learning environments cannot be ignored by users. It may be they *are not* being ignored; albeit, it is possibly a subconscious action that sees teachers adapt and change their practices and their environments in subtle ways, even marginally, to effect better learning. Furthermore, architecture and the built learning environment should not be viewed as a language, but more correctly represents a set of vocabulary and associated contexts. This implies less a need to decode or interpret, but rather a recognition of how built learning environments 'speak'. Individuals consciously and subconsciously recognise a building's voice because they provide identifiable symbolic perspectives that refer to their prior experiences and encounters; they exist in their present, and they reflect forward through the multitude of interactions with all who use them. By their very presence the built environment reacts to the past as well as the 'present' to either invite a new way of operating or 'set' the future to mirror its habitual self. So, this chapter argues less the notion of teacher spatial incompetency, and more the need to theorise and understand the existence of various levels of existing teacher spatial competencies.

'Thought-Like' Architecture, Culture and Context

If this is an accepted notion, the learning environment itself has the possibility of becoming involved in thought or be 'thought-like' in that it represents ourselves, but our objectives are learnt from it; the individual and the architecture are therefore constantly reimagined (Fig. 1). Hays puts it this way; *'Architecture is not a language. Rather, architecture summons into appearance ways of thinking about the world that is otherwise unavailable; it is a particular mode of thought, one irreducible to other ways of thinking…'* (Hays, 2016, p. 205). In this context, the place becomes representational of schools' complex societal structures, purpose and culture.

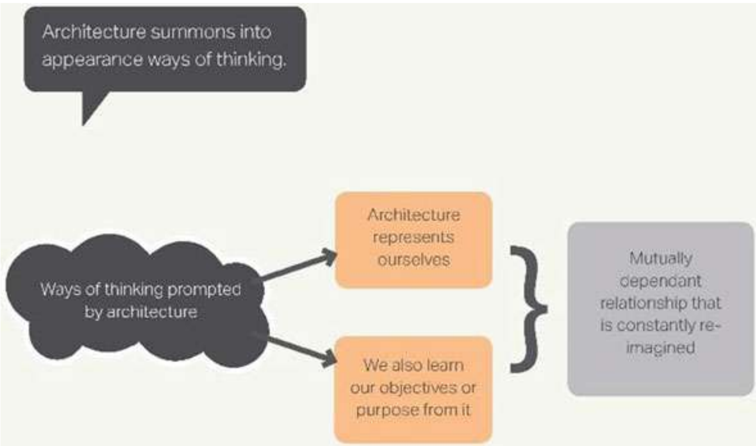

Fig. 1 'Thought-like' architecture

There is a mutual dependence where the built environment becomes involved with its own purpose, for example in the adaption and response of pedagogy through its interaction with the teacher. It is informed by ideology, patronage, designers and users, but can also be understood to be ideological in its own right. It is not entirely determined by its context, but through its very existence, it connects these elements and becomes self-determining. Acknowledging the theorisation around social materialisation (Hays, 2016), it is understood that here there is an epistemological, constructivist claim; that is, something is known about education and learning through the architecture of schools, and; something is known about the nature of learning through the classroom.

Related cognitive factors are also used to conceptualise the activity of teaching and it is recognised they can directly influence a teacher's approach to their professional practice. Drawn from the synthesis of his meta-study (2009), Hattie (2012) termed these factors as mind frames which he categorised into eight key ways of teacher thinking that significantly impact student learning; 'the impact(s) in our schools relates to how we think' (p. 159). In terms of learning environments, 'thought like architecture' confirms the importance of school culture and context to a teacher's thinking (or mind frame) and professional practice.

Teacher Practice

To further consider the impact of these ideas, a broad lens of spatial practice and representation should be applied. Massey recognises space as the 'product of interrelations as constituted through interactions'; 'as the sphere in which distinct trajectories coexist' and 'always under construction' (Massey, 2005, p. 9). In an exploration of Lefebvre's seminal work 'Production of Space' (Lefebre, 1991), Benade (2017) acknowledges the theory that space is socially produced (Tyack & Tobin, 1994); that perceptible and imperceptible qualities of space act as a critical and productive link between the built environment and daily lived experiences. Benade draws on Merrifield's (2006) suggestion that 'spatial practices structure lived reality' (p. 3), inviting further exploration of how occupants and users of space(s) create their own lived realities.

The study of human behaviour recognises that humans operate as individuals who enact roles within a range of complex and interlinked social systems that influence behaviour and social norms. These social contexts are embedded in behaviour patterns and are intrinsically linked to their terrestrial environments. For example, teachers behave as purveyors of knowledge and skill within the setting of their work. The way daily activities are carried out is part of a person's culture; their role in society, their beliefs, attitudes, prior experiences, competencies and purpose. These behaviours are embedded within the individual's environment.

In considering the influence of the setting itself, Lang (1987) argues that architecture is 'culture-bound'. Hays describes this idea as architecture that is a cultural and social representation, or architecture as 'mode of knowledge' (2016). Moreover, he argues that what might be known or present in one era, may not be available to another. This results in a cognitive, imaginative response that mediates every experience with the built environment. Whilst this is being further nuanced by neuroscientists and cognitive psychologists, it is important to acknowledge that this approach accepts the environment to be highly influential on human behaviour.

Consideration should also be given to Lefebvre's triadic of spatial practice, that is; representation of space (conceptualisation); spatial practice (material, lived experience) and representational space (symbolic, mnemonic). These combine into a social production of space; 'the triad of the perceived, the conceived, and the lived' (Lefebre, 1991, p. 40); or 'the three moments of perception, conception and living (which) are simultaneously conscious and unconscious' (Benade, 2017, p. 6).

Furthermore, if it is accepted that school culture represents itself to itself through its built environment, it follows that school communities learn in part about themselves, the function of their school culture, and their purpose, through the education buildings themselves. Moore (1986) in a study that explicitly questioned the interactions and interdependence between social contexts, the architectural environment and human behaviour, concluded that the physical environment 'does not—and maybe cannot—have an independent impact' (p. 227), thereby implying the dependency on other factors.

Architectural and educational research often advocates for training teachers to better use spaces (Woolner, Clark, Laing, Thomas, & Tiplady, 2012). Whilst some visualise this as a parallel, linear interaction of space and practice (Fisher, 2005; Tanner, 2009) whereby the spaces they design somehow bring about contemporary teaching and learning practices (Benade, 2017), it is also important to imagine it as a circular interdependence between spaces and people. This more interactive approach emphasises spatial-skill collateral that is arguably already present within teaching professional practice. If accepted, it can be concluded that teachers are not spatially illiterate, rather we simply don't have mechanisms to recognise their actions or to help use them to improve practice.

Environmental Competency

The term 'spatial competency' has its genesis in the work of Lawton who coined a related term 'environmental competency' in a study examining the environmental needs of the elderly within the context of 'man-environment relations' (1977).

In a review of the literature, many environmental and ecological psychology studies take as their foundation psychologist Lewin's (1936) formulation of behaviour; that is behaviour is the function of the person and their environment. When applied to teacher spatial competency, teacher spatial behaviour can be seen to be dependent on the functional relationship between the person and their school environment. Indeed Lawton used Lewin's ecological equation, $B = f(P, E)$, to devise a schema that proposes competence as 'function' in relation to the 'environmental press' of a place. Lawton defines competence as a term that describes 'essentially what lies within the person' (1977), including a broad set of attributes such as their health, mental capacity and so on. 'Environmental press' he uses as a term to describe elements of a place that promotes or activates behaviour in 'some individuals'. The key point he makes is that the greater the environmental competence of an individual, the less constrained they are by their environment, played out by a demonstration of 'behavioural freedom' (Lawton, 1977). This approach is relatively easy to understand when considering the physical capacities in the elderly, such as motor skills and can be adapted to the concept of cultural behaviour in schools and spatial competency of teachers.

Spatial Competency in Teachers—Early Conceptualisation of the Concept

If it is accepted that most spaces, or learning environments, have possibilities that can be used by a teacher to impact learning, it is often supposed that a critical barrier to teachers' fully utilising their physical learning environment is their lack of environmental 'competency' (Lackney, 2008).

Spatial or environmental competency as a term has since become common currency when discussing how teachers behave within and use space. To date, it has implied a graded scale of behavioural competence that allows some individuals to be highly proficient when interacting with space's affordances, whilst others somehow seem to lag. A teacher who is more adept at manipulating their environment to enhance learning, demonstrated through flexible and facilitated spatial interventions within a classroom, is a good example of perceived 'responsive' spatial competence. The counter to this is the spatially 'incompetent' teacher who supposedly is unable to purposely use an instructional space. Lackney's early study promoted this line of thinking through his 'levels of environmental competence at the individual scale' table (Fig. 2), that scaled and categorised teachers from 'highly proficient' to 'lack of proficiency' (Lackney, 2008).

This spectrum is, however, problematic, not least because it should be recognised that all teachers are situated 'actors' using and responding to space as part of their teaching practice. The reality of this interaction is that all teachers uniquely respond to a large range of confounding variables that influence their output. Furthermore, the idea of scaled competency (in this context) has the potential to lead to a simplification of the concepts under review, and the erroneous conclusion that the classroom (as the built component) is the sole determinant in the teaching and learning transaction; that the classroom is the determining factor (Nair, 2011). This is where architectural probabilism or possibilism comes into play; the suggestion that it is possible to calculate likely teacher behaviour in response to built stimuli, but this would be erroneous and miss the fundamental importance of this conceptual framework.

Level	Description
Highly Proficient	Awareness: There is evidence of an explicit and immediate awareness of the impact of the physical setting on both one's instructional practice and student learning behaviors. Knowledge: Teacher has a working knowledge of relationships between environment and behavior. When the teacher lacks technical knowledge, she is able to articulate the problem and seeks immediate assistance to resolve environmental concerns. Skills: When necessary, the teacher is highly effective in making immediate spatial adjustments that best support his or her purposes and activities.
Proficient	Awareness: There is evidence of a general awareness of the impact of the physical setting on instructional practice and student learning behaviors. Knowledge: Teacher has a general knowledge of relationships between environment and behavior. When the teacher lacks technical knowledge, she is able to articulate the problem, and will on occasion seek assistance to resolve her environmental concerns when they are perceived to be out of her control. Skills: When necessary, teacher is moderately effective in making spatial adjustments that best support the purposes and activities.
Lack of Proficiency	Awareness: There is very little evidence of an awareness of the impact of the physical setting on instructional practice and student learning behaviors. Knowledge: The teacher lacks the ability to articulate the problem when asked, is passively resigned to existing circumstances of the physical setting in which she practices and rarely seeks assistance in improving circumstances. Skills: When adjustments are needed to support purposes and activities in the classroom, the teacher is unclear how to proceed.

Fig. 2 Levels of environmental competence at the individual scale (Lackney, 2008)

> Many designers have made very strong assumptions that the spaces they create will, in themselves, lead to change…It is highly questionable to claim a design will have particular behavioural outcomes without first taking into consideration the predispositions and the motivations of the population concerned (Lang, 1987, p. 102).

It should be understood that architects, designers and educationalists should not rely on what might happen as a result of design in school settings (Lippman, 2010), but rather in what does occur every day. Teacher spatial competency is not deterministic; assumptions can be made, and trends established, but the variables involved discounts absolute certainty. To be clear, teachers need to have observable spatial capabilities, however, these should be relative competencies that are not hierarchical and should be linked to student learning. This new approach puts the teacher metaphorically speaking at the front of the classroom and students in the centre of the action. This is important as architectural determinism, or conversations that prioritise design tends to isolate teachers and consequently disable them in terms of changing their spatial practices, with consequences for student learning experiences.

Teacher Thinking

Environmental Psychology

The work of early psychologists reframed the nature and influence of the human–environment relationship through a substantial body of research resulting in a significant literature of writings. Koffka's seminal work Principles of Gestalt Psychology (1935) was one of the first to distinguish between geographical and behavioural environments. Amongst others, this was followed by Lewin's (1936) formulation of behaviour. It wasn't however until the early 1950s that psychologists and other behavioural scientists began to investigate in depth the interaction between the built environment and human behaviour. This represented a new field that is, respectively, known as architectural, ecological or (and for the remainder of this chapter) environmental psychology.

At a fundamental level, environmental psychology research assumes a correlation and interdependence between environments and behaviour. Goldhagen points out, '*The built environment constitutes the foundation upon which our past, present, and future selves are constructed*' (2017, p. 88).

Gibson (1966) theorised 'potential' and 'effective' environments for behaviour (which specifically considered what a person pays attention to). Weinstein (1981) used an environmental psychological approach to person–environment relations and suggested that the environment communicates 'direct' and 'symbolic' effects on students. Soja (1989) asserted that the discipline of 'critical human geography', a branch of critical social theory, allows for new interpretations of social history seen through the lens of spatial critiques. Soja (1989) pushed this concept suggesting that 'just as space, time, and matter delineate and encompass the essential qualities of the physical world, spatiality, temporality, and the social being can be seen as the abstract dimensions which together comprise all facets of human existence' (p. 25). The abstract dimensions associated with temporality and space explains the complexity of the variables involved (Massey, 2005). Kirk (1990) introduced the consideration of the personal environment with the implication of the importance of personal experience and contexts, which naturally leads to the examination of teacher mind frames and behaviours. These personal experiences take place in classrooms where 'hegemonic pedagogy', or teaching practices that reflect and perpetuate current regimes, is the dominant paradigm (Hildebrand, 1999). Gislason (2010) used behaviour setting theory that assumes 'behaviour is a function of the person and the environment' (Swartz & Martin, 1997, p. 6). He based his theory on Owens and Valesky's (2007), and by deduction after Barker and Gump (1964), conceptual school climate model. Gislason used it as a tool that 'accounts for the relationship between school design, teaching and learning' (2010, p. 128).

The impact of this field of research has been far-reaching. For example, the traditional theoretical viewpoint held by architects, landscape architects and designers proposed that the components of the built environment critically related to each other, rather than human experience. This led to the belief that if the human experiences within a space were different to the designed intention, the fault was 'user error' often attributed to ignorance, lack of education or knowledge (Perin, 1970). Environmental psychology challenged these long-held beliefs. New knowledge about the significance of the environment in our lives has become a central part of the critical discourse about human behaviour.

Situated (or Embodied) Cognition

This research therefore moves beyond a traditional linear understanding of human cognition and experience of environment towards a more interlinked approach that emphasises an associative, non-conscious element that has its basis in the idea of the human physical presence within a space that provides 'situated' or 'embodied' cognition (Barsalou, 2008; Goldhagen, 2017; Johnson, 1987). This idea is important in that it recognises that human cognition and 'place' directly impacts decision-making and ultimately action; that is, human behaviour emerges from the interaction of the physical self (with its unique capabilities) situated in a place, with the opportunities for action offered by that place, at any given time.

It is helpful to consider cognition as the many processes by which people understand, interpret and organise sensory, social and internally generated data for their use. Cognitive psychologists who are advocates for situated cognition argue that the human mind is shaped by the body (human embodiment); and that the human body is shaped by the environment (Barsalou, 2008; Goldhagen, 2017; Johnson, 1987; Robbins & Aydede, 2009). This situated relationship reveals how conscious and subconscious cognitions build up mental schemas or patterns of association. This organisation of data is generated by a range of inter-sensory impressions (involving more than one sense). Individuals have innumerable schemas that are interlocked with the environments in which they live and experience life.

The Potential Environment

Before unpacking these ideas further, it is necessary to explore the framework of the environment itself as a place of potential efficacy. The key to unlocking this potential lies in understanding why a classroom environment embedded with a variety of affordances (that suggest certain behaviours) is not always enacted upon by its users; why some people appear to be more spatially active in their professional practice than others. This is summed up by Lang in this way; ‘Not all opportunities for action are perceived by an individual, nor are all the opportunities that are perceived acted upon’ (1987, p. 80).

The concept of a ‘potential’ environment (Gibson, 1977), in which several possible actions can be played out, is based on studies that explore how humans relate to situations and place. The concept is an abstraction, but it is based on the mental images that are generated when interacting with the environment. This is directly relevant to how a teacher reacts to their classroom in that their behaviour is situated in their cognitive response to the place, which in turn opens (or limits) their responsiveness to its affordances. Their mental image, or imagination, bridges the gap between perception and understanding. Thoughts become material in a person’s response, and the potentials inherent to an environment acknowledged.

This implies space can be defined as a responsive (not flexible) partner. Teachers are very familiar with the term ‘flexible learning environment’, but their experiences of these spaces are often mixed (Benade, 2017; Bradbeer, 2016), and not necessarily aligned to the designed intention. To be flexible implies an elasticity where a form or object always returns to its original state (Fig. 3). This is not the commonly intended outcome for investment in new learning environments, that is for professional practice to be unaffected by the purposely designed space. A building that reacts to something/somebody, that can evolve, converse (give a response to…) and possibly learn (Lippman, 2010) is a better alternative. Lang says ‘What architects create is a potential environment for human behaviour; what a person uses and appreciates is his or her effective environment’ (1987, p. 75). Responsive, adaptive teachers and environments, therefore, have the potential to work together in a new way for the benefit of student learning (Saltmarsh, Chapman, Campbell, & Drew, 2014).

The traditional view that human behaviour is simply a ‘use’ signifier that contributes to the design of a place short changes both architects and the clients they serve. It is often thought that the study of behaviour simply adds to the knowledge about the purpose of a building, however, this is a new emphasis that argues that it has the power to change the very nature of that knowledge (Lang, 1987).

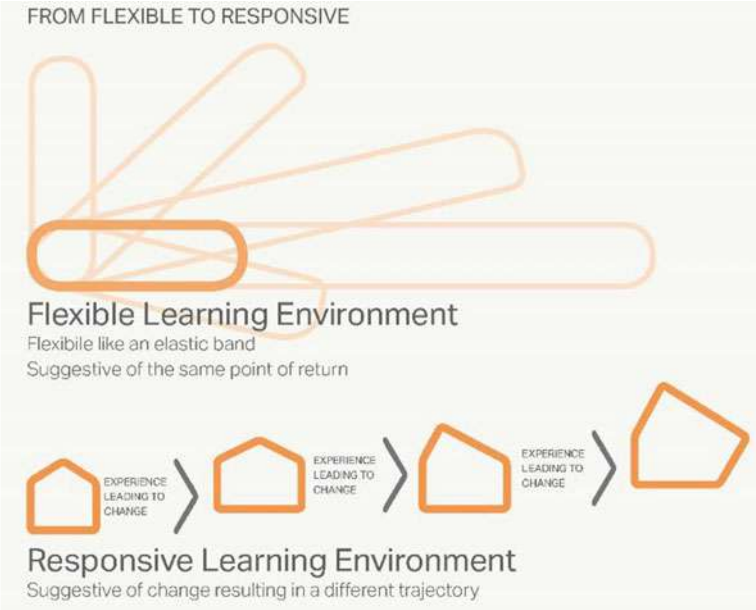

Fig. 3 From flexible to responsive

Architects design school buildings to serve pedagogical and cultural learning purposes, but when a school becomes framed as a potential environment, the relationship between the built environment and the community it serves becomes far more complex, loaded with possibilities. This equation is partly dependent on those that use the space to realise and see its potential (pay attention to it). It is also reliant on architects and designers privileging the influential elements that drive behaviour, such as sensory considerations. Lang reinforces this point; 'built environments will not accommodate people's needs until we integrate what we know and are learning about human experience into their design and composition' (1987, p. 102). This results in prioritising lived experience over (or at least placing it on par) with aesthetics.

Situated Cognition Limitations for Teacher Spatial Interactions

Whilst acknowledging the importance of the principles advanced by this branch of cognitive psychology, this chapter is not a critique of the academic field. That said, it is recognised that it is important not to overstate the findings of cognitive psychologists in the context of teacher spatial competency by considering their claims as a singular principle. These principles of cognitive psychology are relevant to better understanding TSC but do not represent a cohesive framework for understanding the phenomenon. To give an example, consider the assertion that certain visual inputs prime motor activity. A commonly used illustration of this could be a door frame that suggests the act of walking through from one space to another. The simple act of even noticing the door frame requires multiple facilities of knowledge; sense perceptions are needed to take in light waves and interpret them; reason is needed to make sense of the data input; memory checks the current sensory perception again prior experiences; in addition, emotions may be employed as part of this interpretation. All of these make the experience unique to the individual. Wilson (2002), in her examination of the six primary claims of situated cognition, asserts that this type of interaction (door and walking) is more sophisticated and that 'information about the nature of the external world is stored for future use without strong commitments on what that future use may be' (2002, p. 632). Wilson argues that each cognitive arena should be assessed 'according to its own merits'. Wilson's paper, whilst not a rebuttal, disentangles and evaluates the primary claims of cognitive psychologists, concluding that all need to be evaluated in terms of 'the range of their applicability' (2002, p. 635).

The very nature of a cognitive understanding of the environment–teacher equation is that the variables are as variant as the places and actors within them and invites a cautionary approach that is careful not to misrepresent the case.

A Teacher Spatial Competency Conceptual Framework

Teacher Situated Environmental Imagination

To bring together the concepts of spatial practice and situated cognition as a helpful framework for articulating how teachers and environments interact, a concept of a teacher's 'situated environmental imagination' has been developed. This concept brings together the three key domains of a teacher's spatial practice; that is teacher place, practice and thinking. The framework addresses the issues inherent to spatial competencies that are constantly in flux.

Drawing on theories from Kant, Heidegger, Soja and Hegel, and through a long-established theorisation of architectural historiography articulated by Hays (2016), the triadic of spatial practice (the perceived, conceived and lived) also must involve the "gap", or the liminal space in-between the three; a cognitive response which is environmentally situated, socially produced and which determines, regulates and legitimises the lived experience. This response is the link between the different elements that are inherent in every spatial interaction. Interesting to teacher practice, this space is productive (i.e. it moves forwards) and informs the relative relationships between all the elements that contribute to a teacher's spatial competency.

This 'environmental imagination' is multilayered and interdependent. It is cognitively situated or embodied in the environment and it interacts with (and mediates

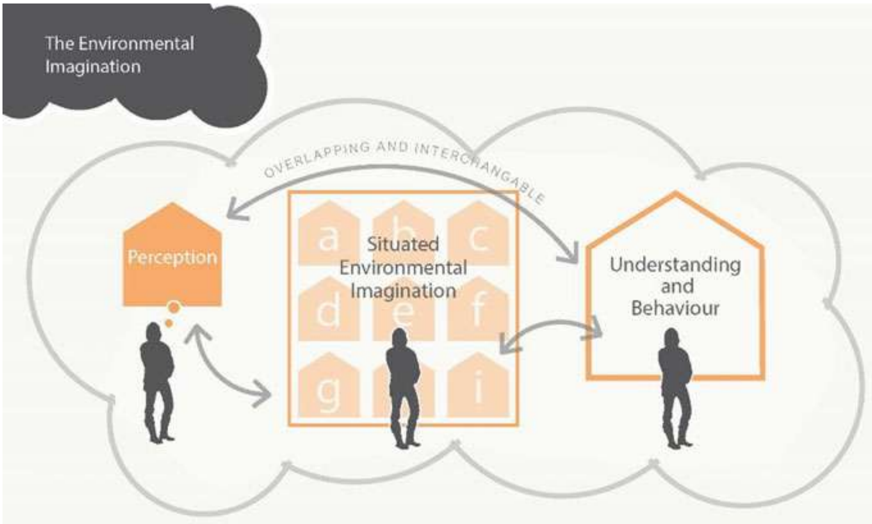

Fig. 4 The environmental imagination

between) a teacher's perception, knowledge and understanding of space, which in turn leads to measurable behaviours associated with spatial competency in the classroom (Fig. 4).

It has an ontological perspective and claim; that architecture exists and 'is' both materially and in the situated environmental imagination of people who perceive it and ultimately use it. Furthermore, something about learning through the nature, the presentness of school architecture becomes known; but the situated imagination also makes and re-makes the concept of teaching and learning in the mind of those using the buildings. The imagination is constantly in flux. It goes beyond simple experience to recognition.

Sensory Information

To understand more fully; the first consideration, accepting the impact of mediating factors such as prior experience, is human intuition (perception) which synthesises aesthetic experiences: that is, the appearance of the architecture or built environment on a sensory level (Fig. 5).

This experience on its own can be limiting. An individual can sense and feel a place, but that information on its own is meaningless. It is purely sensory information. The experience is mediated by the cognitive imagination (knowledge) and a person's mental capacity to visualise. It is still subjective, informed by prior instruction and education about the environment: it goes beyond intuition to recognition, rooted in memory, prior encounters and conceptualisations. That architecture has a mnemonic

Fig. 5 Sensory information and perception

function, it follows that it operates as a 'cognitive map' (Hays, 2016) for the person experiencing the space. The imagination negotiates a schema to organise the array of un-coded sensations. It also needs understanding to turn something purely sensual and material into a cognitive concept. This imaginative element then, in turn, leads to an understanding (conception) of space, which ultimately drives spatial behaviour. An individual's understanding deploys perceptions, categories and cognitive conceptions in an interaction that is informed by this trinitarian architectural interaction. This is an interlocked process in constant flux and anchored by the imagination: they are mutually dependent; they inform each other.

Learned and Instinctive Responses

The non-conscious schemas can be stimulated by 'primes' (Goldhagen, 2017), defined as an environmental stimulus that of itself influences a person's subsequent thoughts and actions (for example, a pungent drain). This is a physiological response, not learned. Alternatively, a (non-conscious) schema can also be constructed from environmental 'metaphors', memory and prior experiences. These responses are learned. Both these categories of cognitive response enable people to connect meaning and associations by drawing from one context and applying it to another (Fig. 6).

This, of course, raises the question of how these metaphors and primes can be employed by both designers and teachers to manipulate or encourage certain types of behaviour. They are in effect schemas. They help individuals understand abstract ideas and concepts and connect them with their lived experiences. Their beliefs and identities are embedded in these experiences.

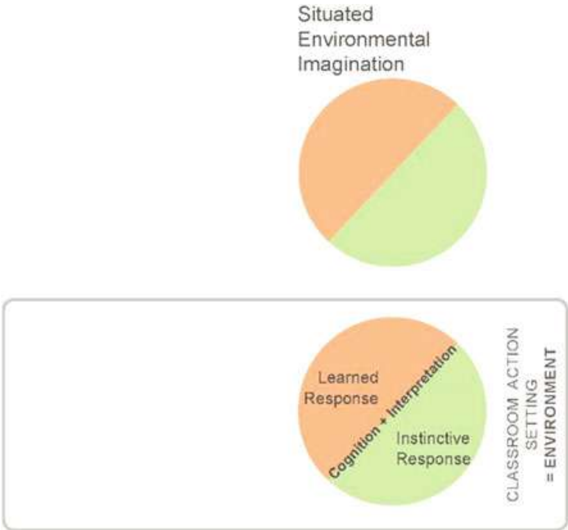

Fig. 6 The cognitive interpretation of learned and instinctive responses

Cognition and Interpretation

All humans interact with space. All teachers, whatever their experience or proficiency, use classrooms as a tool to work within whilst teaching students and promoting learning. Similarly, students are also situated in the space. These interactions are a kaleidoscope of sensory data, 'real-time' cognitions, perceptions, actions and social interactions and are impacted by, and mutually dependent upon, individual and cultural influences, as well as motivational needs. Every individual experience similar levels of complexity as all are all 'situated' in their environment (Robbins & Aydede, 2009). The organisation of the data and resulting behaviour are constantly being reimagined, refined and honed. Therefore, for the teacher perceived as spatially incompetent (or unable/unwilling to utilise a classroom's affordances), this should be understood within the context of the multitude of cognitive interactions that they are processing. Furthermore, it could be stated that this teacher might be spatially competent within the capacity of their perceptions, emotions and experiences. The choices presented by the space and associated primes and cues may not be perceived at all, or even if acknowledged, dismissed precisely because of 'high' competence behaviour triggered by different and unique motivations and associations of an individual.

Wilson (2002) provides a foothold into this complex equation. In breaking down the six main claims of situated cognition, she recognises that whilst cognition is situated, it is also influenced by time-pressure and 'real-time'. She states; 'More sophisticated forms of real-time situated cognition can be seen in any activity that involves continuous updating of plans in response to rapidly changing conditions' (p. 268).

This could be a description of a rapidly changing classroom and suggests that an opportunity to predict or plan outside of the reactive environment could be of assistance. When under pressure where people are forced to work ‘online’ (reacting to the present), Wilson suggests they use a range of strategies to cope, including ‘preloaded representations’ acquired through prior learning; selectively interacting with the environment, leaving unknown elements to be encoded later and altering the environment to lighten the cognitive load. Furthermore, Wilson promotes further investigation into the concept of body-based ‘off-line cognition’, where mental imagery (imagining external events), working and episodic memory (tied to bodied experiences of the world), implicit memory (automating responses) and reasoning and problem-solving are considered as ways to understand how the body influences or even controls the mind. This is important as it implies a framework for working with teachers before their entry into new classroom spaces.

Cognition and Memory

Memory contributes to the human autobiographical sense of self and identity which is associated with the experiences had in lived environments throughout a lifetime.

This idea is reinforced by Goldhagen; ‘We cannot recall a memory from our past without revisiting at least some elements of the place where the original event occurred—if not consciously, then at least unconsciously’ (2017, p. 85). The recollection of a loved primary teacher, for example, involves visualising that person in the classroom spaces experienced as a child. Life events such as graduation are thought of in terms of the place in which it occurred. Similarly, when a teacher considers the cognitive task of teaching, they think of their classroom, the school, even the activities suggested by the affordances available to them to enable them to teach. The act of teaching, the experience, is embedded in the place in which it occurs. Memory allows humans to adapt to new environments and to learn new values through a process of understanding that comes from reinforced, prior experience. How teachers respond to a new learning environment, for example, is a result of their response to the sensory information and patterns present in the space, and how they categorise these elements based on the associations they have built up over time, backed up by any reinforcements they may have experienced. Lackney’s study and Gislason are a good example of research that demonstrates and provides evidence for this pattern of behaviour (Gislason, 2010; Lackney, 2008). What individuals choose in terms of action in response to a setting is the result of their experiences of different places and the objects within them. The actions are taken, therefore, become the experience and continually feed into a personal narrative and identity. This person–environment relationship is a dynamic one.

Cognition and Affordances or Environmental Stimuli

The term 'affordances' was coined by Gibson (1977) and infer that different patterns within the built environment afford or suggest different behaviours and aesthetic experiences. They are a function of both social convention and life history (Chemero, 2003). However, it is the 'experiential opportunities' (Goldhagen, 2017), the *what* people choose to focus on or act upon (either consciously or unconsciously) offered by a places' affordances, that becomes a point of focus for teachers.

Interestingly, Lackney summed up one element of his findings in this way: 'During individual interviews when teachers were asked to describe their perceptions of their school, they tended to identify sensory stimulation concerns, specifically regarding thermal comfort and air quality of the school, followed by problems of noise' (Lackney, 2008, p. 16). That these educators chose to focus on specific sensory concerns would not come as a surprise to those versed in situated cognition theory, or indeed most teacher practitioners in schools today.

Information about the environment is obtained through perceptual processes. This is active and purposeful. Neisser (1976) said, 'it is where cognition and reality meet'. These processes are guided by schemas which are partially innate, partially learned which, in turn, guide emotional responses and ultimately actions and behaviour. The information obtained from the environment has symbolic qualities (giving it meaning), ambient qualities (evoking emotional responses) and motivational messages (stimulating need). Gibson's ecological theory of perception (2015) hypothesises that a wide range of sensory data is always available to us but people only attend to what they know and are motivated to recognise, based on their prior experiences within the environment. More recent studies emphasise that this model of human cognition is not a sequential process. Goldhagen (2017) describes this as the *out there* of environmental perception that is intermeshed with the *in here* of cognition and interpretation, thereby resulting in *out here* action (Fig. 7). Therefore, the environmental stimulus (the 'out there') is not separated from the 'in there' of cognition, rather the elements are inherently interlinked and intermeshed. No boundaries are separating them. In other words, individuals are already, or always (bodily) engaged with the environment. The physical environment that is inhabited is irretrievably linked to human experiences and memory. The individual, and the spaces in which they enact their life is constantly in motion.

Lived experiences are therefore inherently influenced by the environment. What is chosen to be registered consciously or unconsciously is based on the opportunities that are offered by the affordances within the environment. Equally, however, these choices are also embedded in experiences and memory.

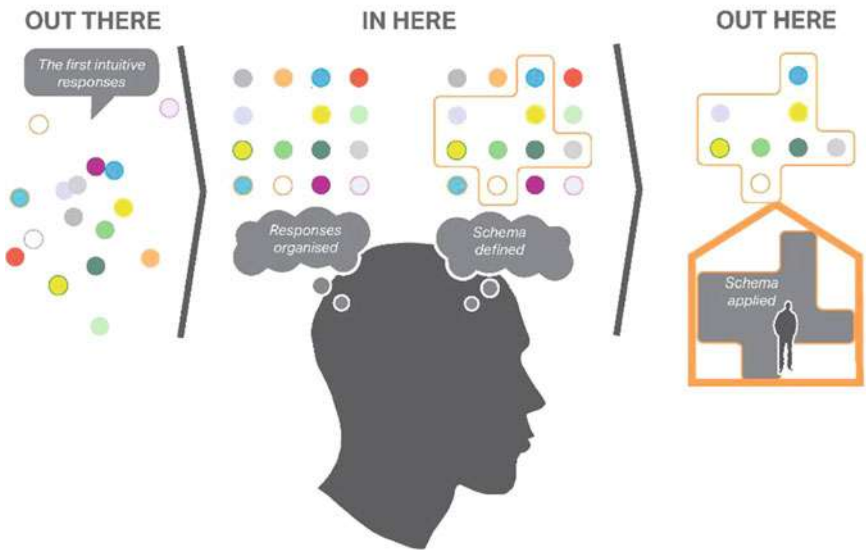

Fig. 7 After Goldhagen: 'out there, in here, out here'

Action Settings

The term 'action settings' has been utilised by Goldhagen (2017) to describe the *animated* nature between the environment and human behaviour. Barker (1968) used a similar term 'behaviour settings' to describe the relationship between the built environment and the standing or recurrent behaviour that takes place in it. Whilst helpful, Goldhagen prefers the term 'action settings' to 'emphasise the agency of humans who make choices within the environments they encounter' (p. 196). This ecological view on human agency is directly related to the environmental conditions through which it is enacted. This can be therefore interpreted as an attribute that can be enacted, rather than an innate ability (Biesta, Priestley, & Robinson, 2015).

In summary, humans *perform* in an environment. They assess its ability to help them achieve their goals; they consciously and unconsciously react to primes and metaphors, influenced by memories that make up the numerous schemas stored in their brains; they, therefore, shape the environment and how it interacts with them. These 'action settings' are places that are not 'mute' but register non-consciously and consciously with the individual (in their imagination), with experiential opportunities offered through its affordances. How they respond is influenced by who they are; the range of responses are as individual as people are (Fig. 8). Human behaviour is influenced by what their conscious and non-conscious brain chooses to pay attention to. It does so using selection principles that it has developed over years of experience in the classroom, as a student, as a student–teacher and as a professional (Goldhagen, 2017). This transaction is determined by the individual's physical presence in the space; the materiality of the space (which help them decide how to engage with it);

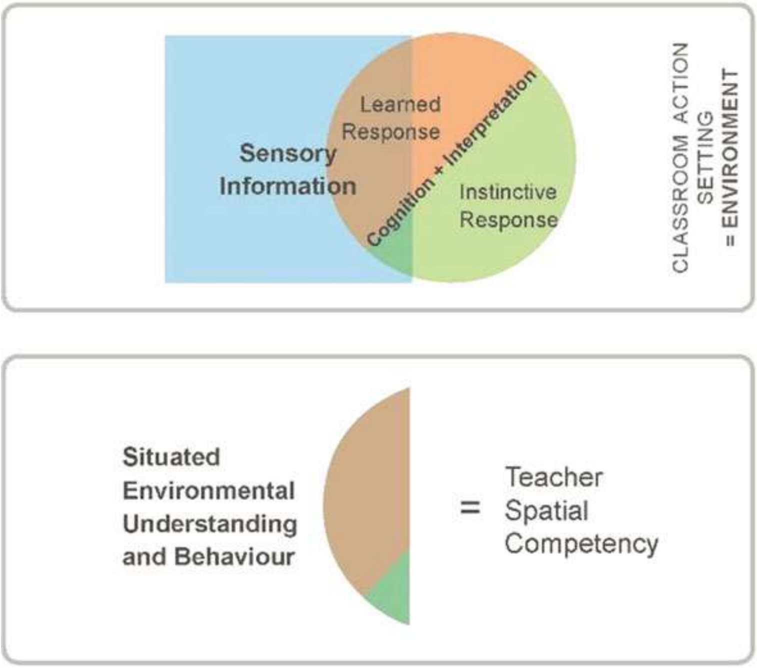

Fig. 8 The components of TSC in a classroom action setting

their perceived assessment of the spaces' usefulness to their goal (to teach); and importantly, if they perceive the environment and its affordances worthy of their attention. This, of course, relies on their ability to understand what space can 'do'. Ulrich Neisser (1976) describes this as 'anticipatory schemata'. People can only perceive what they know how to find.

This transactional, situated cognitive behaviour between individuals and the built environment provides the enabling and inhibiting structure for cultural norms of behaviour. Therefore, the environment is the cornerstone of human life. It shapes a person and their sense of identity and is interwoven with their past, present and future. It is a function of human needs and competencies. Richard Neutra argued 'In that our environment is a form of education, the architect can be considered an educator. Every building schools our senses or shapes our perspective in some degree' (as cited in Nelson & Sundt, 1993, p. 2).

Most human behaviour is accepted as 'reasonable' and 'planned' and follows patterns that are dependent on intentionality and perception (Ajzen, 1985). Teachers' place perception is a matter of past experiences, current environments and imagined futures. These past, current and future place experiences all operate within system constraints. What is important is that those who use the educational places, teachers and students, are taught to see or to be aware of the impact of the environment, and their own experiences, to maximise the potentiality of the setting and make productive choices within the space. When a learning environment is seen as an action setting, the response should be a desire to understand what (already) occurs in school buildings every day. This, in turn, leads to purposeful pedagogical and environmental design, both which shape each other and drives change.

Teacher Spatial Competency Observation and Method

The conceptualisation of the concepts involved with teacher spatial competency suggests that this is a professional teaching competency and skill that has to date sat in the background of teacher professional practice. This has led to a conceptual framework for measuring teacher spatial behaviours, with the further potential to relate these behaviours to student learning outcomes. This framework has defined key guiding principles that, (to borrow from the principles of evaluation theory), '…organises, categorises, describes, predicts, explains, and otherwise aids in understanding and controlling…' (Shadish, Cook, & Leviton, 1991) spatial competency skills.

The conceptual framework requires validation. The best way to do this is to observe actual teaching spatial practice to establish if this conceptualisation is a realistic interpretation of how teachers interact with their environment. If so, validation must also establish that the framework assists in better understanding how this interaction might lead to improved teaching and therefore better student educational experiences. This is the focus of the next phase of the research.

As an observation tool, in the first instance, a three-tiered system has been devised. A 'Teacher Spatial Competency Instrument' (TSCI) has been developed with the task of measuring observable practitioner action related to spatial competency behaviour. The observed behaviour is contextualised using a specialist app that has been developed to record all sensory and material data concerning teacher action settings; their classrooms and school. This data is then visually and verbally analysed by individual teachers through semi-structured interviews aimed at interpreting personal cognitive responses, the situated environmental imagination, verbalised as perception. This interpretation is conducted through the lens of learned (prior) experiences and instinctive responses. It recognises the unique spatial skills of individuals and provides a logic for linking the main proposition to data relating to teacher spatial practice and student learning outcomes.

Conclusion

It is proposed that a situated environmental imagination is a conceptual framework that can be explored to facilitate teacher spatial competencies that effect improved learning for their students (Fig. 9).

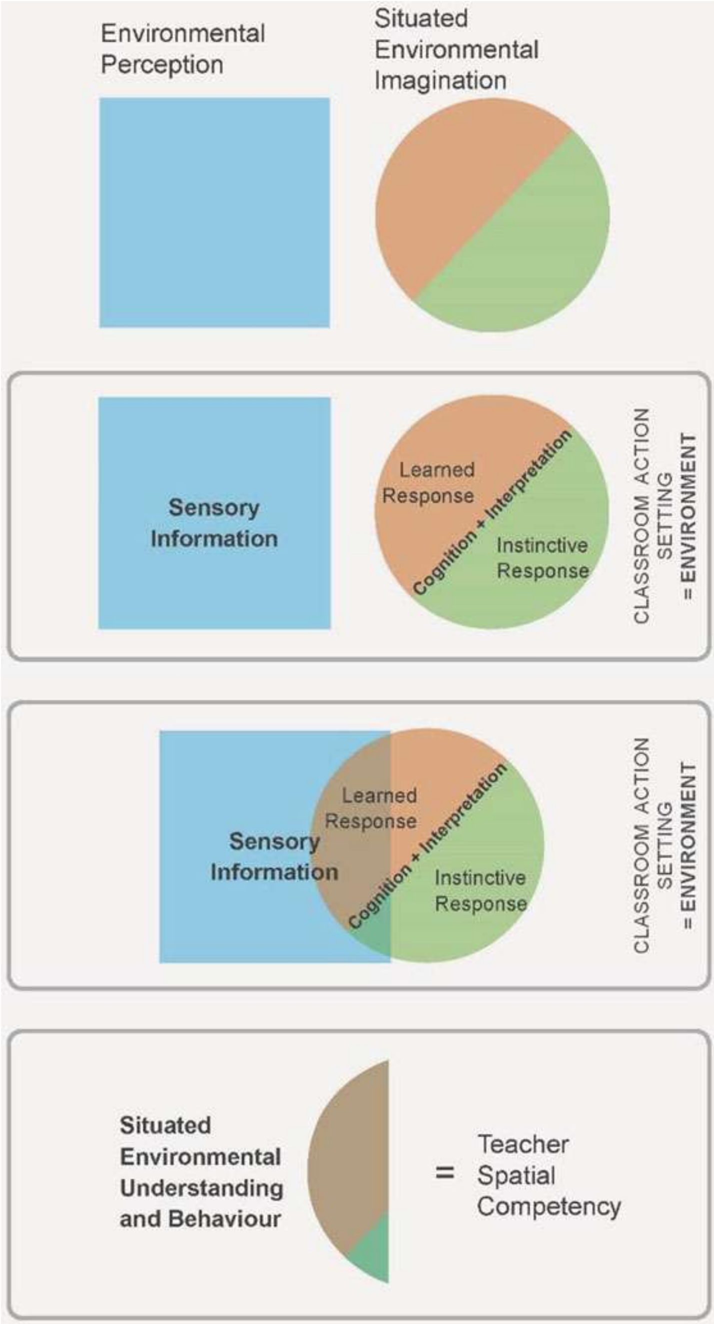

Fig. 9 Teacher spatial competency conceptual framework

The concept can be summarised; the perception of a teacher towards their teaching space (influenced by sensory and symbolic affordances) leads (in their situated environmental imagination) to a mental picture (based on prior encounters, social cues and culture) that is shaped into a schematisation of the space that informs their understanding and knowledge of that environment and influences their behavioural response to it. Each interaction within the space informs the next.

The hypothesis is that this cognitive transaction within the environment is responsive and that what appears to be almost predetermined spatial behaviour in a teacher can be influenced by new knowledge, 'off-line' pre-loaded representations and situated experiences (Wilson, 2002). This ultimately implies that teacher spatial competency can be enhanced to positively influence student learning outcomes through intervention strategies.

This conceptualisation is giving representation and form to what has seemed unrepresentable. It is expressing teacher response to place that is not yet articulated but has rather been seen as 'just the way it is'. It is argued that the teacher, the person who encounters the learning space, experiences a situated environmental 'imaginative' response that is manifested in spatial behaviour and competency. Every encounter is individual but also utilises a collective and social cognition about space. The observation proposal aims to expose this interaction, articulate it, advance proposed interventions (such as 'offline' spatial planning or pre-loading representations) and observe its effect on teaching and learning.

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References

Ajzen, I. (1985). From intentions to actions: A theory of planned behaviour. *Action control: From cognition to behavior* (pp. 11–39). Heidelberg: Springer.

Barker, R. G. (1968). *Ecological psychology: Concepts and methods for studying the environment of human behavior*. Stanford: Stanford University Press.

Barker, R. G., & Gump, P. (1964). *Big school, small school: High school size and student behaviour*. Stanford: Stanford University Press.

Barsalou, L. W. (2008). Grounded cognition. *Annual review of psychology, 59*, 617-645. https://doi.org/10.1146/annurev.psych.59.103006.093639.

Benade, L. (2017). Is the classroom obsolete in the 21st century? *Educational Philosophy & Theory., 49*(8), 796–807. https://doi.org/10.1080/00131857.2016.1269631.

Biesta, G., Priestley, M., & Robinson, S. (2015). The role of beliefs in teacher agency. *Teachers and Teaching: Theory and Practice, 21*(6), 624–640. https://doi.org/10.1080/13540602.2015.1044325.

Bradbeer, C. (2016). Working together in the space-between. In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Evaluating learning environments* (pp. 75–90). Netherlands: Springer.

Byers, T., Imms, W., & Wheaton, A. (2015). Empirical evidence that supports changes to pedagogical practice and tracks learning gains in contemporary and technology-enabled learning environments. Paper presented at the ACER Excellence in Professional Practice Conference Sydney.

Byers, T., Mahat, M., Liu, K., Knock, A., & Imms, W. (2018). *A systematic review of the effects of learning environments on student learning outcomes—technical report 4/2018*. Retrieved from Melbourne: http://hdl.handle.net/11343/216293.

Casey, E. S. (2009). *Getting back into place: Toward a renewed understanding of the place-world*. Bloomington: Indiana University Press.

Chemero, A. (2003). An outline of a theory of affordances. *Ecological Psychology, 15*(2), 181–195.

Fisher, K. D. (2004). Revoicing classrooms: A spatial manifesto. *Forum, 46*(1), 36–38. https://doi.org/10.2304/forum.2004.46.1.8.

Fisher, K. D. (2005). *Linking pedagogy and space: Planning principles for Victorian schools based on the principles of teaching and learning*. Retrieved from Melbourne: http://www.eduweb.vic.gov.au/edulibrary/public/assetman/bf/Linking_Pedagogy_and_Space.pdf.

Gibson, J. J. (1966). *The senses considered as perceptual systems*. London: Allen & Unwin.

Gibson, J. J. (1977). The theory of affordance. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing: Toward an ecological psychology* (pp. 67–82). New Jersey: Hillsdale.

Gibson, J. J. (2015). *The ecological approach to visual perception*. New York: Psychology Press.

Gislason, N. (2010). Architectural design and the learning environment: A framework for school design research. *Learning Environments Research, 13*(2), 127–145. https://doi.org/10.1007/s10984-010-9071-x.

Goldhagen, S. W. (2017). *Welcome to your world: How the built environment shapes our lives*. New York: Harper Collins Publishers.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. New York: Routledge.

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. New York: Routledge.

Hays, K. M. (2016). Architecture's appearance and the practices of imagination. *Log, 37*, 205–213. Retrieved from https://www-jstor-org.ezp.lib.unimelb.edu.au/stable/26324734.

Higgins, S., Hall, E., Wall, K., Woolner, P., & McCaughey, C. (2005). The impact of school environments: A literature review produced for the Design Council, Newcastle.

Hildebrand, G. M. (1999). *Con/testing learning models*. Paper presented at the Australian Association for Research in Education and New Zealand Association for Research in Education Conference, Melbourne. https://www.aare.edu.au/data/publications/1999/hil99582.pdf.

Johnson, M. (1987). *The body in the mind: The bodily basis of meaning, imagination, and reason*. Chicago: University of Chicago Press.

Kirk, W. (1990). Historical geography and the concept of the behavioural environment. In F. W. Boal & D. N. Livingstone (Eds.), *The Behavioural Environment: Essays in reflection, application and re-evaluation* (pp. 38–50). London: Routledge.

Koffka, K. (1935). *Principles of gestalt psychology*. New York: Harcourt, Brace & Co.

Lackney, J. A. (2008). Teacher environmental competence in elementary school environments. *Children, Youth and Environments, 18*(2), 133–159.

Lang, J. (1987). *Creating architectural theory*. New York: Van Nostrand Reinhold Co.

Lawton, M. P. (1977). An ecological theory of ageing applied to elderly housing. *Journal of architectural education, 31*(1), 8–10. https://doi.org/10.1080/10464883.1977.11102585.

Lefebre, H. (1991). *The production of space*. Oxford: Blackwell.

Lewin, K. (1936). *Principles of topological psychology*. In McGraw-Hill publications in psychology.

Lippman, P. C. (2010). Can the physical environment have an impact on the learning environment? *CELE Exchange. Centre for Effective Learning Environments*(11–14), 1–5. https://doi.org/10.1787/5km4g21wpwr1-en.

Massey, D. (2005). *For space* London: Sage.

Merrifield, A. (2006). *Henri Lefebvre: A critical introduction*. New York: Routledge.

Moore, G. T. (1986). Effects of the spatial definition of behavior settings on children's behavior: A quasi-experimental field study. *Journal of Environmental Psychology, 6*(3), 205–231. https://doi.org/10.1016/S0272-4944(86)80023-8.
Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks: Sage.
Nair, P. (2011). The classroom is obsolete: It's time for something new. *Education Week, 29*.
Neisser, U. (1976). *Cognition and reality. Principles and implication of cognitive psychology*. New York: W H Freeman/Times Books/ Henry Holt & Co.
Nelson, D., & Sundt, J. (1993). Changing the architecture of teachers' minds. *Children's Environments, 10*(2), 159–169.
New Zealand Ministry of Education. (2014). *The Ministry of Education's statement of intent 2014–2018*. Wellington, New Zealand: New Zealand Ministry of Education.
Oblinger, D. G. (2006). *Learning spaces*. In D. G. Oblinger (Ed.). Retrieved from https://www.educause.edu/ir/library/pdf/PUB7102.pdf.
OECD. (2013). *Innovative learning environments*: OECD Publishing.
Owens, R., & Valesky, T. (2007). Organizational behavior in education: Adaptive leadership and school reform., Allan & Bacon. Boston: Pearson/Allyn & Bacon.
Perin, C. (1970). *With man in mind: An interdisciplinary prospectus for environmental design*. Cambridge: MIT Press.
Pointon, P., & Kershner, R. (2000). Making decisions about organising the primary classroom environment as a context for learning: the views of three experienced teachers and their pupils. *Teaching and Teacher Education, 16*(1), 117–127. https://doi.org/10.1016/S0742-051X(99)00043-8.
Robbins, P., & Aydede, M. (2009). *The Cambridge handbook of situated cognition*. Cambridge: Cambridge University Press.
Saltmarsh, S., Chapman, A., Campbell, M., & Drew, C. (2014). Putting "structure within the space": Spatially un/responsive pedagogic practices in open-plan learning environments. *Educational Review, 67*(3), 315–327. https://doi.org/10.1080/00131911.2014.924482.
Shadish, W., Cook, T., & Leviton, L. (1991). *Foundations of program evaluation*. Thousand Oaks: Sage.
Soja, E. W. (1989). *Postmodern geographies: The reassertion of space in critical social theory*. London: Verso.
Swartz, J., & Martin, W. (1997). Ecology psychology theory: Historical overview and application to educational ecosystems. In J. Swartz, W. Martin, & J. Swartz-Kulstad (Eds.), *Applied ecological psychology for schools within communities: Assessment and intervention* (pp. 1–25). New York: Routledge.
Tanner, C. K. (2009). Effects of school design on student outcomes. *Journal of Educational Administration, 47*(3), 55–73. https://doi.org/10.1108/09578230910955809.
Tyack, D., & Tobin, W. (1994). The "grammar" of schooling: Why has it been so hard to change? *American Educational Research Journal, 31*(3), 453–479. https://doi.org/10.3102/00028312031003453.
Weinstein, C. S. (1981). Classroom design as an external condition for learning. *Educational Technology, 21*(8), 12–19.
Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review, 9*(4), 625–636. https://doi.org/10.3758/bf03196322.
Woolner, P., Clark, J., Laing, K., Thomas, U., & Tiplady, L. (2012). Changing spaces: Preparing students and teachers for a new learning environment. *Children Youth and Environments, 22*(1), 52–74. https://doi.org/10.7721/chilyoutenvi.22.1.0052.

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The Spirit of 'WE' in the Learning Environment: 'WE LEaRN'—A Space for Students and Teachers to Become

Anat Mor-Avi

Abstract This chapter advances the idea that in order to improve twenty-first-century learning environments for students and particularly for teachers, it is necessary to enhance the spirit of collective culture, called 'WE', versus the spirit of individualism, called 'I', and provides an example of how this is reflected in the design of learning spaces. Both of these cohorts use learning, working and doing processes, and face major changes from educational mandates. A 'WE' cultural environment will be discussed in order to support multiple aspects of collaboration and creativity, where hub-specific solutions empower the two groups as collectives, supporting a 'WE LEaRN HUB' setting. Connecting practice to research, a process of change in school design related to the 'WE' culture is presented through an academic park built in Israel. This academic park uses an introductory design of the hub's setting approach, supporting the 'WE' of both communities and reflecting new approaches in learning processes.

Introduction

Formerly, the goals of education and the design of learning places were based on a homogenised factory-like model (Scott-Webber, 2004). The new model of twenty-first-century's educational practices advocates the creation of knowledgeable and adaptable people who can develop and share new knowledge with others and influence a new economy (Robinson, 2011). Passive learning is gradually being replaced by active learning to enhance the motivation, curiosity, creativity, and collaboration skills in learners.

The idea of learning as a dynamic, multi-directional process, which acts as a social and playful one, creates a challenge to define spaces for learning geared towards certain activities, while opposing past centuries' practices. It is suggested here that we need to explore wider ideas and agendas; as author Boys (2011) introduces in her book *Toward Creative Learning Spaces*, learning is not a linear process (see Fig. 1).

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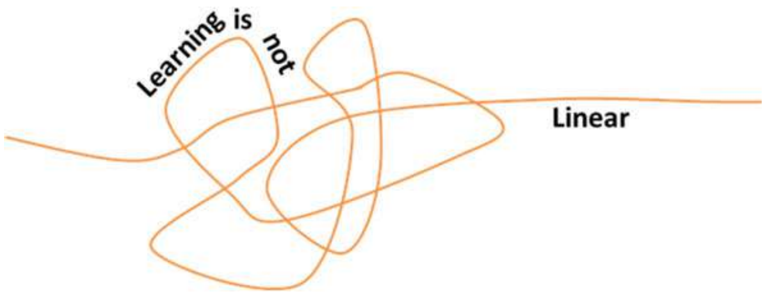

Fig. 1 Learning is a dynamic process (adapted from Boys, 2011)

Today, students as well as teachers are thought to be learners. Education is evolving, incorporating the knowledge of how we learn and the ways to enhance students' and teachers' collaboration and motivation (Boys, 2011). According to psychologist Sawyer (2007), creativity is always collaborative. Organizations that want to change for the better should encourage collaborative group settings, moving to team organization, enhancing their own reserves of creativity, and distributing leadership.

In his book *Group Genius*, Sawyer (2007) refers to many innovations that affect our lives, which emerge from group genius. The unique power of collaboration generates unique interacting opportunities resulting in a string of successive ideas—each spark lighting the next and enhancing creative solutions and innovations. 'When we collaborate, creativity unfolds across people; the sparks fly faster, and the whole is greater than the sum of its parts', writes Sawyer (2007, p. 7). In an effective creative community, innovation emerges over time and from the bottom up, enhancing deep listening that helps build ideas as extensions of the preceding ones, and transforming ideas into good questions and outcomes (Sawyer, 2007).

Similarly, Clapp writes in the book *Participatory Creativity* (2017) that creativity, like learning, is a social process circulated through the class by participation, not a process that happens in isolation. He also argues that reframing the understanding of creativity as a socially distributed process is a necessary first step to ensure that a greater number of learners gain access to creative learning experiences, through which they will further develop their own creativity. Collaboration is central to creativity (Clapp, 2017). Adding to this claim, Robinson (2011) too suggests that 'creativity is about connections and is usually driven more by collaboration than by solo efforts' (p. 211).

The notion that learning and the learner are affected both by technology and by knowledge of the way we learn suggests that social values in schools should assume greater importance (Scott-Webber, 2014). However, in reality the collaborative culture of teachers and students in learning environments is in constant flux, complex and includes many old paradigms. The changes towards a more collaborative culture of learning and working affect both the teachers and the students, as separate groups as well as a united group, and are subsequently summed up.

Students: From Being Served to Peer-to-Peer Learning

Students learn best when working together (Beichner et al., 2007). In addition, better retention and achievement are influenced, by far, from peer involvement and student–teacher interactions. Therefore, students are encouraged to collaborate and learn to become team members rather than being passive listeners. These changes, however, are challenging, in view of longstanding assumptions that traditional environments are crucial to serious learning and success—a clear indication of behavioural conditioning according to Scott-Webber (2004). How may these changes begin to happen?

Teachers: From Lonely Superheroes to Group Wisdom

A starting point for change is the teacher, and some of the best resources for teacher success are their colleagues. Hence, the collaborative culture is equally important for teachers. Grose (2014) suggests that effective shifting of teachers' practices in order to address the changes in today's education is achieved when teachers are enabled to shape changes both collaboratively and collectively. In addition, after a history of closed doors and teaching conducted in traditional ways, it is essential that teachers are equipped with time, space, and incentives to perform as interest-driven individuals in a collaborative culture, while each individual may enrich the system by virtue of his or her specialization, strength, and uniqueness. This culture should be similar to the practices conducted in future-oriented organizations (Hattie, 2009), whereby the workforce is in the process of shifting from individual-focused work towards 'WE' activities empowered by collaborative spaces (Nonaka & Takeuchi, 1995).

Teachers and Students: Empowering Engagement Skills

The culture of collaboration must also be applied between students and teachers. In a study by Ray and Kafka (2014), it has been argued that despite the understanding that student–teacher interactions have a positive influence on students' skills of engagement, only 14% of surveyed graduates reported actively engaging with teachers. It would seem that traditional pedagogical approaches, lecture type classes and row-settings are still considered a more serious and safe learning model by many students and teachers. In a similar vein, Hattie asserted at a 2017 lecture on the topic of collaboration that although the importance of collaboration is clear, it is difficult to scale up the sense of collaboration among all users in the learning process as a culture.

Employing architectural attributes to build a learning culture based on connectedness and collaboration could be a powerful catalyst to sustaining those changes. These attributes should reflect the meaning of connectedness and the notion of 'WE', which will be explored in the following sections, through the prism of culture, behaviour, and environment.

Connectedness and Collectiveness

Many current approaches to education are based on collaborative processes. Collaboration is necessary for creativity in its contemporary concept, in order for it to flourish. Social culture and the act of collectiveness (i.e. the quality or state of being collective) could support it. Connectedness has been defined by Goodenow (1993) as 'the extent to which students feel personally accepted, respected, included, and supported by others in the school social environment' (p. 80). Goodenow (1993) also reports that school connectedness has been found to correlate strongly and positively with students' academic motivation and with indexes of school performance and adjustment. In addition, a study by Shochet, Dadds, Ham, and Montague (2006) noted that school connectedness is an under-emphasized parameter in adolescent mental health. Therefore, it is crucial to create a holistic culture of connectedness and collectiveness among students and particularly teachers—the 'WE' culture, as it is called in the present study. To fully identify the aspects of 'WE', the current social and cultural changes need to be considered.

Culture Change

In the digital era we are willingly becoming less private and less individual. New social, cultural, and economic patterns are shaping a new kind of collectiveness empowered by individuals acting in collective actions (ex. crowdsourcing, crowdfunding, and crowd wisdom). We are moving from a society of individuals to a society of collective individuals, a new collective, the new 'WE', where the act of collectiveness is performed and is not related to the ideologies and aims of collectivism of the past. The new 'WE' is unique in that it is a dynamic notion, such that one may be part of many collectives, or multiple 'WE's.

The power of the crowd indicates that we are smarter and more creative when together and supports the argument that we ought to create more collaborative cultures (Nagar, 2011; Surowiecki, 2004). Trust, Krutka, and Carpenter (2016) support this notion by stating that isolation is the enemy of improvement. The state of non-isolation derives from the more basic concept noted by Lieberman (2014) that the most fundamental human need is to connect with others.

Although in flux, the common culture is still 'I'-oriented, evoking concern as noted by philosopher Martin (2016). Martin suggests that two major, forgotten concepts be included in the educational agenda: (a) three Cs—Care, Concern, and Connection, and (b) extensively expanding the 'WE' definition—in school, in society and even when referring to our planet. It seems that those missing Cs are budding in social platforms where interest-driven individuals join a collective action. Individuals in such groups are considered to be more creative in comparison to those in other types of groups (Goncalo & Staw, 2006).

The goal-oriented individuals often collaborate through online platforms which, according to Trust et al. (2016), are growing and empowering the users. However, Jenkins, Ito, and Boyd (2016, p. 7) advised that instead of thinking of technologies in isolation, 'we would do better to take an ecological approach' and promote physical encounters in learning communities. While Seelig (2012) observes that educational environments and learning culture may repress students' creativity, it is clear that the design of learning spaces should holistically embrace the social and cultural patterns of collaboration, reflecting the social and goal-oriented connections for all users.

Environmental Behaviour

Behaviour that is involved in engagement, motivation, satisfaction, and positive attitude towards peers, teachers, and learning, enhances the level of connectedness in schools. Evidence shows that synergy between pedagogy and the environment has a positive influence on the behaviour of students and teachers, as well as on soft skills necessary for the twenty-first century, such as engagement and collaboration. In the current social shift, individuals are encouraged to share their skills and knowledge in collective activities, in order to empower the collective (WE) and advance their personal achievements (I). The current shift should be presented holistically by new patterns of relations in the educational landscape, where fulfilled students and teachers act as compassionate collectives. Therefore, empowering each cohort's community (i.e. students and teachers), as two groups of individual learners acting in collective activities, may be the basis for encouraging a 'WE' community that supports new relationships.

A Relation-Shift in Learning-Driven Environments

In view of the ongoing culture flux, it seems that the relationship between the 'I', the 'ME' and the 'WE' are being challenged. The 'I' is the inner aspect of the person, while the 'ME' represents one's social aspect, namely what is learned in interaction with the surroundings and other people's thoughts and attitudes. The 'ME' includes knowledge of both the environment and of society, in addition to one's sense of self (Meads, 1967). Therefore, being a strong social 'ME' empowers the 'WE' culture in learning-driven environments (see Fig. 2).

Fig. 2 The ME + WE > I concept

These concepts are understood as fluid and often changing between different cultures, regions, and environments. It has been suggested by the literature that, for many reasons, we are individuals who should be connected in creating a shift towards new relationship patterns, described as a 'Relation-Shift' (Hertzberger, 2008) where strong individuals create strong social- and interest-driven collectives. Therefore, pedagogy, users' attitude and space should integrate to become the catalyst for a 'WE' culture in schools, with the space encouraging connectedness among all users.

The Meaning of 'WE' Espouses the Argument for Collaboration, Creativity, and Leadership from Inside-Out

In view of all of the above, there is a perceived need to empower both teachers and students by creating a spirit of communal learning culture by encouraging the social 'ME' and the 'WE' for each group, versus the spirit of individualism, the 'I'. This is particularly necessary for teachers, given that teachers' spaces still illustrate signs of isolation (Scott-Webber, 2017).

A key message in Hattie's book *Visual Learning* (2009) is that what works best for the students is similar to what works best for teachers. Visual learning is one of the fundamental pillars of openness and sharing in education that enhance the connection and the networking between learners of both groups. The 'WE' correlates with the idea calling for education to be treated as a public and communal domain. Therefore, the 'WE' concept has the potential to empower (a) peer gathering, (b) task or interest-related connections, and (c) collaborating in informal and formal knowledge-sharing places.

The school is where learning and working converge with two major groups of users in different doing and learning modes. The qualities of progressive, creative workplaces and innovation labs should become integrated into twenty-first-century learning places. Thinking, learning, and doing should be made more visible, and the notion of the user experience (UX) of formal learning is then supported in an informal setting. This suggestion is supported by Covey's principles (as cited in Fonzi & Ritchie, 2011), which are based on three beliefs calling for leadership by choice and not by hierarchical model: (1) 'All individuals, including students, are given the opportunity to lead (p. 3)'; (2) All people regardless of age, race, class, gender, or disability should develop skills such as leadership, accountability, adaptability, and problem solving; (3) 'Innovation will be diffused through a ripple effect from teachers and staff members to…students and the surrounding community (p. 4)'. Covey's idea, which he defines as *inside-out leadership*, emphasizes the importance of empowering the collective culture.

Therefore, the spaces enabling a 'WE' culture should provide qualities for collaboration and interactions as well as leadership without a hierarchical culture. The ability of the teachers to collaborate could become a model for the students. Thus, a hub which includes design attributes such as transparency, mobility, and proximity between students and teachers' spaces are to be considered.

Creating Hubs for Students and Teachers: A Potential Model

Environments have very important impact on forming behavioural patterns (Scott-Webber, 2004; Senge, 1990). Hence, the nature of the 'where' in the learning environment should be empowered. Architectural attributes that empower the 'WE' culture of learning environments should be promoted holistically in school design. The 'WE' cultural structure should offer spatial formations optimizing innovative approaches to learning and working. One idea is to have innovative labs for each group, with a shared space in-between to support students' and teachers' development together as team players, in order to promote connectedness in learning-driven environments. This should be done through visual thinking, learning, and working, as conducted in many other organizations and innovation labs, thereby exploring the design attributes of mobility, proximity, and transparency. These attributes are introduced in this study, in a three-area learning hub model, the '2 + 1 WEHUB' (see Fig. 3), supporting:

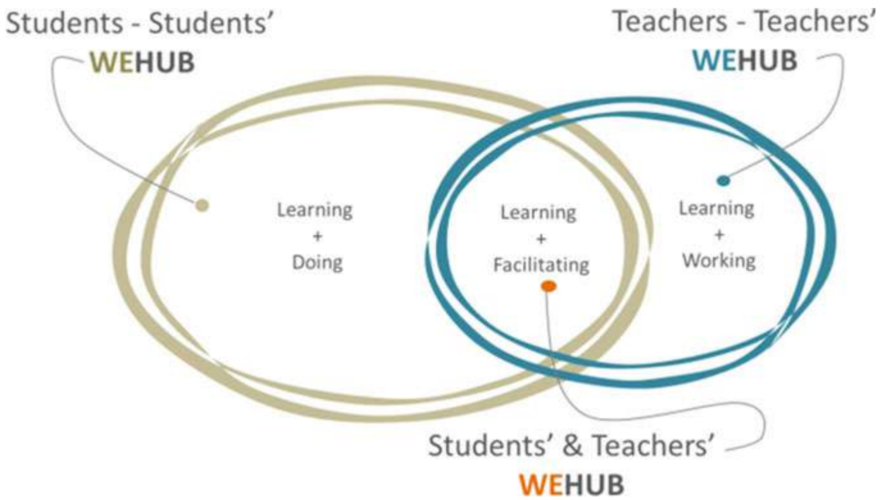

Fig. 3 The 2 + 1 WEHUB model

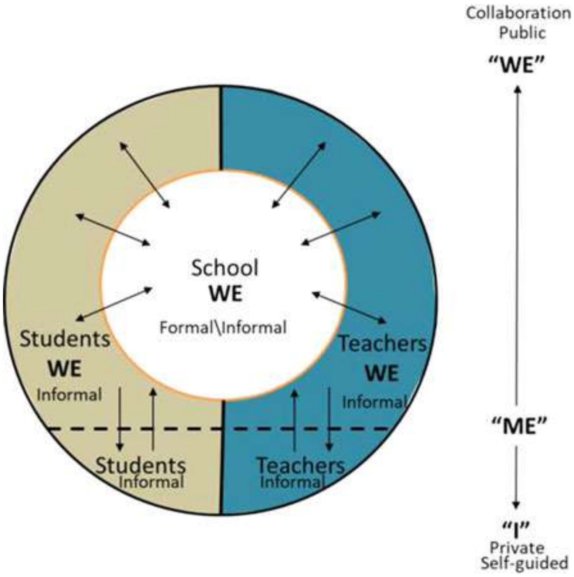

Fig. 4 2 + 1 WEHUB model—through WE, ME and I

1. Students' hub for learning and doing.
2. Teachers' hub for academic working and learning.
3. Interconnecting hub designed for both students and teachers to connect and collaborate.

The '2 + 1 WEHUB' model creates the opportunities for students and teachers to increase the potential for operating as two groups, independently and jointly. Accordingly, the spaces reflect each of the collective needs while the third place hosts both collectives for learning and working together. Simultaneously, the WEHUB supports the needs of the individual 'I', the 'ME' (the social I) within the 'WE' culture, by creating healthy relationships between private, public, formal, informal, self-guided, and collaborative spaces (Fig. 4).

The process in school design, which responds to these dynamic needs and changes, will be discussed in a case study of a three-school Academic Park located in Israel, representing the evolution of the connectedness culture in schools.

A Glance at an Ongoing Change in Practice—From Small Gestures to a New Paradigm

In Ganey Tikva, a fast-growing township in the center of Israel, an academic park (GTAC) is being developed which includes a library-incubator for innovation, an elementary school, a middle school, and a high school. Despite the need to follow the

Fig. 5 GTAC: Eliot elementary school 2016

Ministry of Education’s strict and traditional programme, an opportunity to observe the gradual change in the physical layout is evident. In early 2016, Eliot Elementary School (1st–6th grades) was inaugurated, offering a small common area for alternative study in-between the traditional classrooms (see Fig. 5).

In September 2016, the adjacent Meitar HS (9th–12th grades) was inaugurated, offering open classrooms as study halls for students to collaborate, while the teachers’ working areas were kept apart. The school’s pedagogical principles are collaboration, listening and responsibility, and all communities involved are expected to become open sources for all. In addition, Meitar HS was chosen as a lab for future pedagogical strategy innovation by the Ministry of Education, thereby promoting a unique experimental future-oriented curriculum for teachers, students, and the community. Accordingly, the main architectural attribute offers full transparency qualities for professional and alternative spaces, and partial transparency qualities for the homerooms. Also, all classrooms were equipped with movable furniture and accessories inviting the sharing of ideas and collaboration (see Fig. 6).

It is important to note that in Meitar HS, the teachers who are most open to change and embrace the collaboration culture are second-career teachers who convey qualities from various disciplines of the high-tech culture. In Meitar HS, 64% of teachers joined the educational field from other domains. This reflects a phenomenon in Israel whereby, according to the Central Bureau of Statistics, more than 25% of the teachers come from the high-tech fields to join the educational system of 1st–12th grades. Hence, it is necessary to provide them with spaces reflecting the collaboration qualities to which they are accustomed and to support them in leading the change. Consequently, the design of the middle school, which is connected academically to Meitar HS, was influenced accordingly. Further factors impacting on the design include informal remarks by educators of the Research & Development Department at the Israel Ministry of Education, which have been gathered to shed light on the additional desired qualities for the ‘WE’ culture formation:

Fig. 6 GT academic park: Meitar high school 2016–17

1. Students' 'WEHUB' should have qualities of makers' workshop with physical and mental opportunities for connections and collaboration.
2. Teachers' 'WEHUB' should support an informal gathering space as 'kitchenette time' and non-schooling functions, to encourage communicating, working, and resting in settings which enhance the principle of participatory leadership as introduced by Moeller, the co-founder of 'Art of Hosting' (Moeller, n.d.).
3. The interconnected 'WEHUB' should have the qualities of a mentoring hub with different scales of encounters.
4. Motivating terminology should be used.

Accordingly, the design of the middle school, planned for 7th–9th grades, reflects the '2 + 1 HUB' model supporting the act of connectedness for all users. This school, inaugurated in September 2018, adopts meaningful strategies towards the culture of change in learning. A new layout was introduced, whereby all areas that are not homerooms will function as hubs for learning and doing—providing informal, formal, private, and public qualities for each group and in the interconnecting area. This 'WEHUB' will include 'WE LEaRN' areas for students and 'WE WORK' for teachers on the same floor, all to support connectedness through mobility, proximities, and visual relations via transparency (see Figs. 7 and 8).

The three schools represent a process of change in the architecture of schools towards patterns introduced in collaborative culture organizations, by including opportunities for all users to collaborate in informal while defined settings. However, adopting changes is a complex process for all users, and it is therefore necessary to evaluate the connection between education and design (Imms, Cleveland, & Fisher, 2016). While most of the research on creativity within organizations focuses on psychological and social aspects of engagement, there is a lack of inclusive research regarding building environments for creativity, and the complex relationship between space, creative behaviour, and innovation (Groves & Marlow 2016). Future steps are needed to connect practice and research through examples such as the 'WEHUB' model introduced in this chapter.

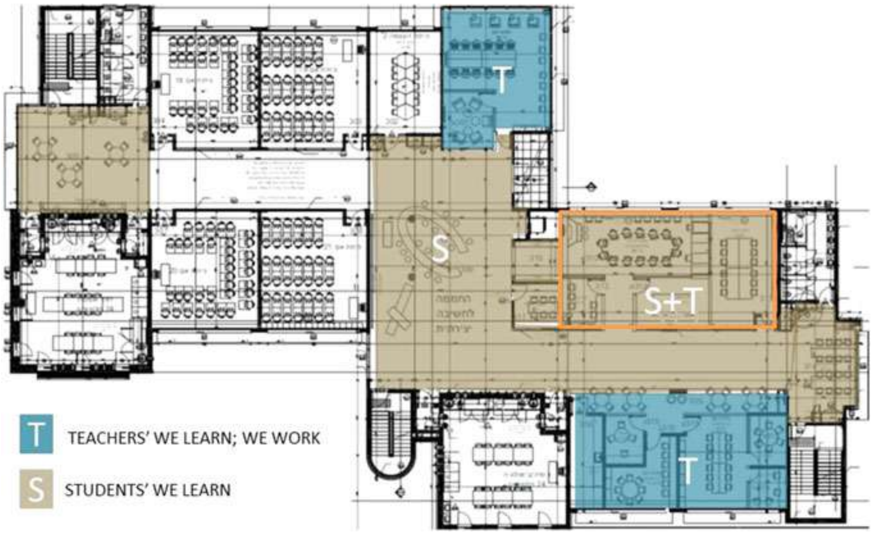

Fig. 7 GT academic park: middle school 3rd floor; WEHUB plan

Fig. 8 GT academic park: middle school 3rd floor; WEHUB bird eye view

Summary

This chapter discusses the theory underlying collaborative learning and the benefits of enhancing the spirit of 'WE' for teachers as well as for students versus the spirit of 'I', in learning environments. Ganey Tikva's Academic Park was introduced as a case study in the transformation towards informal learning and working environment areas for students and teachers. Moreover, this chapter contends that based on the phenomenon in Israel whereby many teachers join the educational system from a corporate-collaboration culture, it is vital to address the teachers' particular need for environments that support and empower their abilities to perform as a collective in collaborative patterns. Accordingly, a 'WEHUB'-like setting was introduced in the middle school last designed at the Academic Park, where the art of collaboration can be performed among students and teachers as separate groups that are occasionally combined. The architecture of the 'WEHUB' nurtures connectedness by enhancing visual relations through transparency, supporting informal opportunities by proximity, encouraging participation and creativity through mobility—all in order to hopefully augment the wisdom of the collectives in school.

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References

Beichner, R. J., Saul, J. M., Abbott, D. S., Morse, J. J., Deardorff, D., Allain, R. J., … Risley, J. (2007). The student-centered activities for large enrollment undergraduate programs (SCALE-UP) project abstract. *Physics, 1*(1), 1–42. Retrieved from http://www.percentral.com/PER/per_reviews/media/volume1/SCALE-UP-2007.pdf.

Boys, J. (2011). *Towards creative learning spaces: Re-thinking the architecture of post-compulsory education.* New York, NY: Routledge and A Taylor & Francis Group.

Clapp, E. (2017). *Participatory creativity-introducing access and equity to the creative classroom.* New York, NY: Routledge and A Taylor & Francis Group.

Fonzi, J., & Ritchie, K. (2011). *The leader in me: Research literature review*. Rochester, NY: University of Rochester, Warner School of Education.

Goncalo, J., & Staw, B. (2006). Individualism–collectivism and group creativity. *Organizational Behavior and Human Decision Processes, 100*(1), 96–109.

Goodenow, C. (1993). Classroom belonging among early adolescent students: Relationships to motivation and achievement. *The Journal of Early Adolescence, 13*(1), 21–43. https://doi.org/10.1177/0272431693013001002.

Grose, K. (2014). *From 21st century learning to learning in the 21st century: Influences on transforming teacher knowledge of constructivist practices in technology-rich learning environments.* Ph.D. Dissertation. University of Toronto, Department of Curriculum, Teaching and Learning, Toronto, ON.

Groves, K., & Marlow, O. (2016). *Spaces for innovation: The design and science of inspiring environments.* Amsterdam, NL: Frame Publishers.

Hattie, J. (2017) *Collaborative impact, keynote at "Collaborative Impact: Research & Practice Conference"*. Cognition Education. New Zealand. https://visible-learning.org/2017/05/video-john-hattie-collaborative-impact/. Accessed May 20, 2017.

Hattie, J. (2009). *Visual learning: A synthesis of over 800 meta-analyses related to achievement*. Oxford, UK: Routledge and A Taylor & Francis Group.

Hertzberger, H. (2008). *Space and learning.* Rotterdam, NL: 010 Publishers.

Imms, W., Cleveland, B., & Fisher, K. (2016). *Evaluating learning environments: snapshots of emerging issues, methods and knowledge.* Rotterdam, NL: Sense Publisher.

Jenkins, H., Ito, M., & Boyd, D. (2016). *Participatory culture in a networked era.* Cambridge, UK: Polity Press.

Lieberman, M. (2014). *Social: Why our brains are wired to connect*. New York: NY: Crown Publisher.

Martin, J. R. (2016). *Why school must change*. New Philosopher‘s editor Zan Boag interviews. Boston, MA. University of Massachusetts. Retrieved from http://www.newphilosopher.com/articles/why-school-must-change/.
Mead, G. H. (1967). *Works of George Herbert Mead, Vol. 1: Mind, self, and society. From the standpoint of a social behaviorist*. In Charles W. Morris (Ed.). pp. 174–186. Chicago London: University of Chicago Press. ISBN 9780226516608.
Moeller, T. (n.d.). *Art of hosting*. Retrieved http://www.artofhosting.org/what-is-aoh/.
Nagar, Y. (2011). *What do you think? The structuring of an online community as a collective-sensemaking process*. Cambridge, MA: CCI Working Paper 2011-006.
Nonaka, I. & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. *Communications and Network, 9*(1): n.p. NY: Oxford University Press.
Ray, J., & Kafka, S. (2014) *Life in college matters for life after college*. https://news.gallup.com/poll/168848/life-college-matters-life-college.aspx.
Robinson, K. (2011). *Out of our minds: Learning to be creative*. West Sussex, UK: Capstone Publishing Ltd., Wiley Company.
Sawyer, K. (2007). *Group GENIUS: The creative power of collaboration*. New York, NY: Basic Books.
Scott-Webber, L. (2004). *In sync: Environment behavior theory and the design of learning places*. Ann Arbor, MI: The University of Michigan, Society for College and University Planning.
Scott-Webber, L. (2014). The perfect storm: Education’s immediate challenges. In L. Scott-Webber, J. Branch, P. Bartholomew, & C. Nygaard (Eds.), *Learning space design in higher education* (pp. 151–168). Oxford Shire, UK: Libri Publishing.
Scott-Webber, L., Konyndyk, R., French, R. Lembke, J. & Kinney, T. (2017) Spatial Design Makes a Difference in Student Academic Engagement Levels: A Pilot Study for Grades 9–12. *European Scientific Journal*, *13*(16): 5–18. ISSN: 1857–7881 (Print) e - ISSN 1857–7431.
Seelig, T. (2012). *inGenius: A crash course on creativity*. New York, NY: Harper One.
Senge, P. (1990). *The fifth discipline the art and practice of the learning organization*. New York, NY: Doubleday/Currency.
Shochet, I., Dadds, M., Ham, D., & Montague, R. (2006). School connectedness is an underemphasized parameter in adolescent mental health: Results of a community prediction study. *Journal of Clinical Child and Adolescent Psychology, 35*(2), 170–179.
Surowiecki, J. (2004). *The wisdom of crowds*. USA: Anchor Books.
Trust, T., Krutka, D. G., & Carpenter, J. P. (2016). ‘Together we are better’: Professional learning networks for teachers. *Computers & Education*. https://doi.org/10.1016/j.compedu.2016.06.007.

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Addressing the Socio-Spatial Challenges of Innovative Learning Environments for Practicum: Harmonics for Transitional Times

Emily Nelson and Leigh Johnson

Abstract A shift to Innovative Learning Environments (ILEs) in New Zealand schools is a current Ministry of Education strategic direction challenging how we as teacher educators prepare candidate teachers (student teachers or trainee teachers) to teach in these emerging environments. Candidate teachers in our primary teaching degree increasingly are placed in ILEs on practicum as these develop in schools in our geographic area. Our students report anecdotally that teaching in ILEs poses them steep and novel challenges around how they plan, teach, assess, manage students and learning, as well as work collaboratively with associate teachers and, increasingly, other colleagues. With our current programme underpinned by a more conventional image of teaching and learning, and schools transitioning between conventional and arguably more innovative, bespoke environments, we wondered how our students navigated the novel pedagogical and physical configurations they encountered in ILEs on practicum. We conducted focus group interviews with our candidate teachers and recent graduates who had completed one or more practicum in an innovative learning environment (as defined by the practicum school). We explored participants' perceptions of the particular demands ILEs created for them. Utilising Lefebvre's (The production of space. Trans. Blackwell, Cambridge, MA, 1991) socio-spatial trialectic and Monahan's (Built pedagogies & technology practices: designing for participatory learning. Palo Alto, CA, 2000) notion of "built pedagogy" in this chapter we identify key socio-spatial entanglements, or harmonics, that emerge from our analysis and explore how these inform how we might better prepare our candidate teachers in these transitional times.

The Material Disruption of ILEs for the Education Sector

Emerging from the OECD, the concept of innovative learning environments (ILEs) acts to re-conceptualise education for the supposed needs of contemporary society (Cleveland & Fisher, 2014). Based on transversal principles of how children learn

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and the conditions that support, learning and teaching in ILEs is underpinned by commitment to teacher and learner collaboration, student agency, flexible learning arrangements, ubiquitous technology use and inquiry pedagogies that are enacted in collective learning hubs. In the New Zealand context, the transition from conventional cellular configurations of teaching and learning to the collaborative and flexible hubs of ILEs was prompted by a policy imperative (Ministry of Education, 2011) requiring that all schools modernise their teaching and learning environments by 2021 (this has more recently been softened to "encourage" schools to develop ILEs if this is their preferred direction). However, the "spatial literacy" (Imms, Cleveland, & Fisher, 2016, p. 6) required to enact learning and teaching in ILEs adds a "significant layer of complexity" (Fletcher, Mackey, & Fickel, 2017, p. 71) for teachers. For instance, the more collaborative teaching practices these spaces lend themselves to, come with consequent expectations on teachers—being more adaptive, flexible and relational (Whyte, 2017). This can represent significant material disruption for many teachers, students and parents. Thus, it can be argued that implementing ILEs involves more than a simplistic assumption that changes to buildings will shift and support changes to pedagogy. As Bradbeer et al. (2017) foreground, the change prompted by ILEs involves the "embodiment" of "pedagogical beliefs in the day-to-day practices of the school" (p. 22) and the need to engage with educator, parent and student conceptions of schooling, learning and teaching (Benade, 2017).

Amongst this dramatic shift in conceptualising learning and teaching in schools, preservice education practices are challenged to respond to this changing view of how we should learn and teach. Not only does a shift to ILEs involve significant capability development for experienced educators and leaders (Whyte, 2017), such a shift poses significant challenges for candidate teachers, and initial teacher education (ITE) providers. These challenges are intensified by the reality that at the time of writing, approximately 75% of teaching and learning in schools continues to be within single-cell learning spaces with teacher-led pedagogies, meaning ILEs and their attendant practices are still in the minority (Imms, Mahat, Byers, & Murphy, 2017). Preservice teacher education needs to straddle this diversified reality when preparing beginning teachers for teaching. During the transitional time we are witnessing, with preservice programmes predicated largely on conventional visions of learning and teaching, candidate teachers are challenged to "translate" their campus learning experiences into appropriate practices for the bespoke ILEs they may inhabit on practicum when their reference points are more than likely conventional.

The authors practice as teacher educators within a New Zealand regional, practice-based primary teaching degree. The degree was collaboratively conceptualised, designed and enacted between a group of local Principals, the ITE provider and a group of learning design specialists from other ITE institutions and professional development organisations. Candidate teachers engage two days per week in campus-based classes and two days per week engaged in "school-based learning" tasks within one partnership school. In addition to the weekly school-based learning programme candidate teachers also participate in block practical placements across the three years of their degree. In 2015 a minority of our candidate teachers began to experience ILEs on practicum. Additionally, given the close nature of our partnership, the teacher educator team was increasingly challenged to adapt school-based learning and practicum requirements to respond to the bespoke configurations of the ILEs emerging in our partnership schools. For us space had become a "prominent consideration" (Bradbeer et al., 2017) as we endeavoured to disrupt our taken for granted beliefs about learning and teaching and consider how to prepare our candidate teachers for ILEs. We wondered: With more candidate teachers experiencing ILEs on practicum, how were they grappling with these new environments and the pedagogical challenges these posed, given that we were simultaneously grappling with the implications of these emerging socio-spatial arrangements for our programme curriculum, pedagogy and supervisory practices? This issue framed the research being presented in this chapter.

Theoretical Framing

ILEs hold the capacity to re-conceptualise both the social relationships and spatial arrangements of learning and teaching. To understand this potential, the authors utilise Lefebvre's (1991) socio-spatial trialectic and Monahan's (2008) notion of built pedagogy that "make sense" of these environments, the pedagogies they promote and what these mean for candidate teachers navigating ILEs on practicum. Rather than being an inert container to house social activity, Lefebvre views space as socially produced, alive and layered with the perceptions, experiences, and theorising of those who inhabit them in particular ways. From a socio-spatial perspective "learning spaces and the uses made of these are created and sustained together in a *mutually constitutive* relationship" (Mulcahy, Cleveland, & Aberton, 2015, p. 6). We agree that space is always political, imbued with discourses and ideologies, dynamic, and open to ever-present possibilities of disruption and transformation (Lefebvre, 1991; Monahan, 2008).

Lefebvre identifies three spaces that taken together form a socio-spatial trialectic. The first "perceived space" frames the familiar and the expected. In the context of preservice education this space includes "course content and assessment, field placements, school and university pedagogies and practices" (Ryan, 2011, p. 887) and interrelationships between all these practices. The second "conceived space" comprises the "ideals"—how "society should be" (Ryan, 2011, p. 887). In the context of initial teacher education conceived space refers to the "professional standards, course accreditation and the structure of university and school procedures to produce 'ideal' future teachers" (p. 887). The third "lived space" represents the coming together of the perceived and conceived through the in-action decisions of social actors such as candidate teachers, associate teachers and teacher educators. The lived space is a space of imaginings and possibilities, "the space where pre-service teachers can make choices about which […] practices/ideologies they might interrupt or resist and how they might do so in their own time and space" (p. 888).

Ryan argues that the perceived, conceived and lived spaces entangle, all three continuously enacted, exerting influence on each other and producing particular harmonics of embodied practice.

Monahan's (2000) notions of "built pedagogy" and "embodied material conditions" theoretically locate our work. Monahan contends that "Built environments enable and constrain certain modes of social action and interaction, educational structures embody curricula and values by design" (p. 1). The "embodied material conditions" of a space generate "messy materialities" and investigation is needed to explore the ways in which the material, "shape[s] lives and establish[es] social orders" (Monahan, 2008, p. 99).

Instructing candidate teachers to negotiate these intertwined spaces of ILEs on practicum is under-researched. They are expected to teach in ILEs whilst simultaneously negotiating the high-stakes requirements of the practicum as an assessed experience. In practicum experiences, "pre-service teachers are expected to make the connections between often-contradictory spaces with little or no guidance on how to negotiate such complex relationships" (Ryan, 2011, p. 881). With the advent of ILEs, we contend the challenge is intensified. ILEs are changing the education landscape so rapidly that our formal institutional change and review processes are inadequate to respond in a timely manner in the short-term. Instead we decided to talk directly with our candidate teachers who had been successful in ILE practicums, to find out how they navigated learning to teach in these spaces on practicum in the aim of re-conceptualising our own practice, and programme, informed by them.

Methodology

Our qualitative, small-scale exploratory research explored how our candidate teachers enacted learning to teach in ILEs on practicum. We were interested in how they translated their beliefs, and those they encountered on campus and in schools, into embodied day-to-day practices (Bradbeer et al., 2017). Nine candidate teachers participated in the study; each of whom had experienced at least one practicum in an ILE during years two or three of their degree. This small sample size is indicative of the emergent nature of ILEs in our geographical area at the time of conducting this research, and the small cohort sizes of our boutique programme.

We utilised focus group interviews (Morgan, 2004) as our data generation strategy. This approach enabled us to explore the challenge of ILEs for practicum from the candidate teachers' perspectives, in a way in which perspectives shared could be challenged, augmented and contrasted. We anticipated a focus group approach would also provide the reflective and educative opportunity for participants to reflect and debrief their learning around teaching in ILEs that Whyte (2017) identifies as key to making sense of practice as part of learning to teach. The three 45–60 minute focus group interview transcripts generated were audio-recorded and professionally transcribed.

One main research question framed our research: "How do candidate teachers learn to teach in Innovative Learning Environments (ILEs) on practicum?"

We developed our focus group interview protocol around areas central to practicum that we anticipated might be different in an ILE to a conventional single-cell classroom experience. Our protocol invited participants to discuss: characteristics of ILEs experienced, approaches to planning, approaches to pedagogy, support and guidance needed and received, necessary skills and dispositions for teaching, technological capability required and practices that supported student ownership of learning.

We utilised a constant comparative approach (Silverman, 2005) to analyse the focus group interview transcripts. The constant comparative approach involved us firstly conducting an emic data analysis to generate an emergent framework of themes important to participants' experiences in their ILE practicums. For example we identified "tinkering" as an emic code that described a disposition towards candidate teachers playing with the affordances of particular technology apps before enacting these with their students. Three participants discussed tinkering as an approach that they used to prepare for teaching that became more important in ILEs because of the need to fit in with other teachers.

We developed this emic coding framework during analysis of the first interview transcript, then applied it successively to the second and third transcripts, refining the emergent framework with each iteration and re-applying new codes until we were satisfied we had accounted for all the data. We conducted the data analysis separately in the first instance, then met together to debate, define and provide examples for each code until we reached consensus.

We also conducted an etic analysis of the data by using the broad topics of our focus group interview questions, Monahan's (2000) elements of built pedagogy and Lefebvre's three spaces as codes. For example Monahan's notion of "fluidity", or "Design of space for flows of individuals, sight, sound and air" (n.p.) enabled us to engage with participants' descriptions of the characteristics of ILEs to identify the flows they expected to find and the "lived" realities of the bespoke practicum environment. Through this we realised participants theorise ILEs more than we had expected, given very little consideration of ILEs in our programme curriculum at the time.

To illuminate the socio-spatial we used axial coding processes to produce socio-spatial harmonics, the interconnections we identified between the perceived, conceived and lived spaces that participants discussed. Codes that co-occurred, and that we deduced were related, were linked together to produce three harmonics that addressed how candidate teachers learned to teach on an ILE-situated practicum.

The harmonics were:

1. Collegial Collaboration;
2. Responding to the particular rhythmical practices of ILEs and
3. Negotiating messy materialities versus the "ideals" of teaching in ILEs.

We present these harmonics as themes in the sections that follow, after describing the characteristics of the ILEs our participants inhabited on practicum.

Fig. 1 Typology of spatial design (*source* Imms, W., Mahat, M., Byers, T, & Murphy, D. (2017). Reprinted with permission from the ILETC project)

Characteristics of the ILEs

The nine participants drew on their experiences of 11 ILE practicums in the focus group interviews. The contexts are presented in relation to Dovey and Fisher's (2014) spatial typology adapted by Imms, Mahat, et al. (2017) (Fig. 1).[1]

All the ILE contexts the participants experienced were retrospective adaptations of existing classrooms and other spaces (school hall, cloak rooms, etc). All ILEs were in their first 2 to 3 years of operation, with most in their first year. Table 1 arranges the 11 practicums in relation to the spatial typology presented.

Table 1 shows that four of the ILEs encountered were characterised as type A environments, essentially involving between one and three teachers teaching collaboratively within a traditional classroom space. Participants described experiences within five type C environments where classrooms had been modified to enable the use of breakout spaces and flexible pedagogical arrangements. Interestingly, these

[1]This has been developed over time through various LEaRN projects, but acknowledgement must be made to Drs. Kenn Fisher and Kym Dovey for the original conceptualisation; Dovey, & Fisher, (2014). Also to Dr. Pippa Soccio for the graphic representation.

Table 1 Spatial typology breakdown

Cluster type	Characteristics	Number
A	Traditional classroom	4
B	Traditional classrooms + street space	
C	Convertible classrooms	5
D	Convertible street space	1
E	Dedicated commons	
Unsure		1

type C environments were identified as the least prevalent type of ILEs in New Zealand in the initial findings of the ILETC project (Bradbeer et al., 2017), but characterised five of the 11 spaces encountered by our participants.

Collegial Collaboration

Supporting teachers to collaborate forms an underpinning ubiquitous ideal and design principle of ILEs (Bradbeer, 2017). However, participants described the complexity collaboration produced for their supervisory relationships on practicum. Teaching on practicum in ILEs upscaled practicum supervision relationships from a predominantly one-to-one mentoring relationship with one associate teacher, to a one-to-many collegial relationship.

The spatiality of the ILE context required participants to plan collaboratively with multiple colleagues, taking responsibility for different groups of learners across curriculum areas and year levels.

> The way I planned is that I planned in conjunction with both teachers that were in the classroom. So it was after school we would talk about which parts I'd be taking and which parts they'd be taking. So I had responsibility for the year fours for maths, so I'll plan just strictly for the year fours and the other teacher would have responsibility for the year threes.

The rhythm of planning and implementation was intensified in terms of it happening every day with expectations around implementation for the next day. This is considerably different to the expectation in our preservice curriculum that candidate teachers would plan in advance for stable groupings of learners (e.g. a reading group, or multiple reading groups) and that over-writing be used on the formal lesson or unit plans to indicate where adjustments would be made for insights gained from working with each group. Participants described opportunities for enhanced collaborative responsibility for planning positively, emphasising the support and feelings of competence they gained.

> I felt that my AT [associate teacher] supported me a hundred percent. The other teacher let me take over her job. It was great, it had its downfalls but, yeah.

Despite the complexity produced, the increased access to colleagues supported participants with their confidence around planning and teaching.

> If you've got an idea and you're not entirely sure you can clarify it with someone […] in my case there was a really experienced teacher and then a teacher that had only just come out of her practice. […] So that helped me develop and also I felt confident approaching a lesson knowing that I was well prepared.

These feelings of value and competence seemed to be reinforced by the fact that often the associate teachers themselves were new to teaching in ILEs, creating space for candidate teachers to contribute to how the material disruptions (Monahan, 2008) and discourses around teaching in new ways in ILEs were negotiated.

Responding to Rhythmical Practices of ILEs

Within "built pedagogy" "the design of learning spaces must take into account how the space-time compression engendered by information technology affects learning rhythms … built pedagogies … emerge relationally through rhythmical practices that occur within these spaces" (Monahan, 2000, n.p.). With participants placed in hubs with responsibility for learners from up to three "home classes", they noted this arrangement caused them difficulty with getting to know the needs of learners in short timeframes:

> At [School] we had a three week rotation on PE where one teacher took the same thing just three times in a row and the three home classes rotated round each teacher. So it was, yeah you just plan for the general feel of the class.

Participants discussed how they planned for the feel of the class in response to short timeframes and being expected to teach students from within larger groups. Planning for the "feel" of the class is not a practice promoted in our preservice curriculum. The compressed time scale of planning in ILEs disrupted expectations of the perceived space of campus where "knowing your learner" and "diagnosing learning needs" are important aspects of pedagogy that traditionally take place over a longer time frame and are informed by data.

The rhythmical practices of ILEs also posed a classroom management challenge for candidate teachers:

> Managing lots of students. I think being able to think on the spot and just, well, reflect on action isn't it, yeah how to make those quick changes to make improvements.

ILEs intensify the need for candidate teachers to enter practicum with a sound and solid understanding of learning progressions to make quick collaborative decisions about next learning steps as a key part of the collaborative and flexible teaching role.

Reconciling the Rhetoric with the Messy Materialities of Teaching in ILEs

Many participants described struggles with the messy materialities of ILEs which, at times, differed from the rhetoric of ILEs as innovative and an advance on conventional classrooms. Participants mediated their in-action decisions through the "shoulds" they brought to the ILE practicum, gained from the perceived space of campus and from broader media coverage of ILEs.

> The one I was in, it was in a hall, so the hall had been taken out but it was just an open plan setting. It had a couple of different level tables, bean bags, but nothing really that stood out to be what an ILE is for me. It was just this bunch of furniture put into a room, basically.

This perspective resonates with the "confusing array of designs" (Bradbeer et al., 2017, p. 24) that constitute ILEs. Candidate teachers must interpret and respond to the bespoke nature of the ILE on practicum.

Attending to messy materialities also included negotiating informal furniture arrangements whilst they taught, for example bean bags.

> Can I just interrupt you, the bean bags were an absolute pain in the arse. They were absolutely horrible, like good for relaxing, but not for when you want to have a learning environment, because they're just squeaking and moving around all the time.

Noise and distraction produced by teaching alongside other teachers and groupings of students within the same space challenged the novice teachers also.

> Yeah I think the noise level was an issue when I was in there. I was taking one class and another teacher was taking her class and if they got up to do an activity for whatever reason, it would distract the class I was teaching and the noise was just too distracting, personally.

Most participants linked issues with acoustics to spatial design.

> Well, the one at [School,] that was sound-proofed quite nicely and the L shape that it went in, you couldn't really hear the noise from this room when you were in either of these two home spaces here. The teachers had it set up quite well. Even if the kids were talking it was a bit of a quiet hum. The one I was in this year was, yeah, just everything seemed quite close together and if you were sitting here doing some teaching and there's another teacher there, it was difficult to block out the noise I guess from the other group of kids.

Integrating digital technologies into their teaching in practice did not always align with the realities of the ILE. Campus curriculum highlighted the importance of purposeful integration of technology as an aspect of effective pedagogy:

> [Teacher educator] touched on it when we did one of the courses. The technology […] should enhance or morph the task into something deeper than what could be done without the device.

Participants struggled with technology integration that seemed to promote student independence at the expense of rich learning. One participant discussed Pic Collage posters as an example.

> It's not that there's not a place for a pic collage like that 'cos there is a place for that, it might be on your reading task board you know, but it's not teaching, that's not using technology for learning […] I've got so little time in a day, I can't imagine just getting them to make a poster unless it had valuable learning within it, it would just, there's just not enough time for that sort of stuff.

Dominant discourses of IT also promise "democratic access" and '"friction-free" exchanges of capital' (Monahan, 2008, p. 89). However, participants encountered proprietary barriers with some of the digital platforms their schools subscribed to limit their ability to enact teaching fully in the virtual spaces of their ILE hubs. As one participant described:

> I only had access to Teacher Dashboard through my teacher's laptop so I only used it in the morning to send my stuff out, 'cos it was a programme on her laptop. I didn't actually have access to it while I was teaching so I couldn't look at the children's screens unless you're actively there and it's hard. What do you do when you're teaching a group to make sure that you can still monitor those children?

The pedagogical expectation of monitoring student learning was disrupted in the lived space of the ILE practicum. Even for those participants who described having limited access to learning management systems, they were often not able to take full advantage of the affordances of these platforms because they did not have *full teacher* access. This messy materiality created a tension with the entangled expectations from the preservice programme that encourage e-learning as an aspect of effective pedagogy (Ministry of Education, 2007) and the reality of not being able to fully embody this aspect of the teaching role.

How Do Candidate Teachers Learn to Teach on Practicum?

Despite some misalignments between the ideal and realities of the lived ILE practicum, our findings suggest that the material disruption (Monahan, 2008) ILEs create for experienced teachers opened up new opportunities for candidate teachers to inhabit the teaching role on practicum as respected colleagues. In all cases participants found themselves entering "spaces under construction" where teachers were trialling new spatial and pedagogical practices and seemed to welcome philosophical and decision-making input from their preservice colleagues. This contributed to enhanced feelings of self-efficacy for candidate teachers. Upscaled supervisory relationships opened up opportunities for candidate teachers to enact significant collaboration, and share pedagogical responsibility with multiple colleagues. It appeared that this was welcomed more in the planning than in the teaching process, as distraction and noise level associated with teaching in concert with other colleagues were identified as messy materialities of teaching in ILEs that challenged candidate teachers.

The ILE practicum did require significant "translation" by candidate teachers between the conventional image of teaching and learning promoted during campus-based learning and the bespoke and dynamic arrangements of the ILEs. The challenge to respond to individual learner needs whilst simultaneously responding to the orchestration challenges of fitting in with two or more collaborating colleagues were significant. Intensified rhythmical practices of ILEs disrupted the vision of stability they were prepared (on campus) to expect. Rather, a fast-paced flexible and highly responsive lived reality of ILEs suggests we need to prioritise practices of collaborating, key learning progressions and management of larger groups in our preservice curriculum to better prepare candidate teachers as adaptive, flexible and relational colleagues (Whyte, 2017).

Disparity of access by candidate teachers to the virtual spaces of ILEs, due to proprietary barriers, constrained them from inhabiting the teaching role fully at a time where this was most needed. In this way technology acted as a barrier to the candidate teachers, providing discourses contrary to those propounded. This dissonance put their success at risk in a number of ways. Candidate teachers must demonstrate their competence as a developing teacher during practicum; it is an assessment task in itself. Fully participating through the technological space of the hub, to relate to learners and to collaborate with colleagues, is vital.

Framing our work with a socio-spatial lens has enabled us to focus on "elements of inter-connection" (Mulcahy et al., 2015) between campus learning and ILE learning for candidate teachers and the harmonics produced. These harmonics challenged our existing thinking. Our participants talked about their campus experiences as supports for engaging with the challenges of ILEs as social spaces new to them, whereas we, initially, viewed campus and practicum as separate spaces. We now think of these spaces as entangled like a mobius strip, with our candidate teachers translating experiences from campus classes, arranged primarily for conventional visions of teaching and learning, and enacting these, under torsion, in ways that address the lived challenges of the ILEs they inhabit on practicum.

Through the process of this analysis the authors found we are thinking about our practice, in a more entangled way. The uses made of technologies by candidate teachers on practicum and their views of "purposeful use", are influencing what, when, how and why we introduce certain technological platforms in our programme. Emphasising the skills of working collaboratively has become an essential aspect of developing pedagogical knowledge in our programme. We need to deepen candidate teachers' curriculum knowledge and knowledge of key learning progressions so that they are better prepared for the intensified pace and collaborative nature of decision-making around teaching and learning in an ILE (Alterator & Deed, 2013). More generally, we need to promote "material disruption" and "messy materialities" as ubiquitous aspects of ILEs and to promote heuristics such as Imms, Cleveland, et al. (2016) spatial typology as key reference points for our candidate teachers to identify the continuities that underpin the bespoke physical and pedagogical design features of their particular ILE. These innovations are essential as a basis for building our candidate teachers' capacities, and our own capacities, to generate adaptive practice in these bespoke spaces during practicum.

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References

Alterator, S., & Deed, C. (2013). Teacher adaptation to open learning spaces. *Issues in Educational Research, 23*(3), 315–330.

Benade, L. (2017). Is the classroom obsolete in the twenty-first century? *ACCESS: Contemporary Issues in Education, 37*(1), 28–40. https://doi.org/10.1080/00131857.2016.1269631

Bradbeer, C. (2017, August). Teacher collaboration in flexible learning environments: Rhetoric vs reality. In E. Nelson (Chair), *Primary Education Research Symposium.* Symposium conducted at Eastern Institute of Technology. Taradale, New Zealand.

Bradbeer, C., Mahat, M., Byers, T., Cleveland, B., Kvan, T., & Imms, W. (2017). The "state of play" concerning New Zealand's transition to innovative learning environments: Preliminary results from phase one of the ILETC project. *Journal of Educational Leadership Policy and Practice, 32*(1), 22–38.

Cleveland, B., & Fisher, K. (2014). The evaluation of physical learning environments: A critical review of the literature. *Learning Environments Research, 17*(1), 1–28. https://doi.org/10.1007/s10984-013-9149-3.

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *The Journal of Architecture, 19*(1), 43–63.

Fletcher, J., Mackey, J., & Fickel, L. (2017). A New Zealand case study: What is happening to lead changes in effective co-teaching in flexible learning spaces? *Journal of Educational Leadership Policy and Practice, 32*(1), 70–83.

Imms, W., Cleveland, B., & Fisher, K. (2016). Pursuing that elusive evidence about what works in learning environment design. In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Evaluating learning environments: Snapshots of emerging issues, methods and knowledge* (pp. 3–20). Rotterdam, The Netherlands: Sense.

Imms, W., Mahat, M., Byers, T., & Murphy, D. (2017). *Type and use of innovative learning environments in Australasian schools.* ILETC Survey No. 1. Melbourne, Australia: University of Melbourne, LeARN. Retrieved from http://www.iletc.com.au/publications/reports.

Lefebvre, H. (1991). *The production of space. Trans.* Cambridge, MA: Blackwell.

Ministry of Education. (n.d.). *Innovative learning environments.* Retrieved from http://ile.education.govt.nz/#home.

Ministry of Education. (2007). *The New Zealand curriculum: For English medium teaching and learning in years 1–13.* Wellington, New Zealand: Learning Media Limited.

Ministry of Education. (2011). *The New Zealand school property strategy 2011–2021.* Retrieved from http://www.education.govt.nz/assets/Documents/Primary-Secondary/Property/SchoolPropertyStrategy201121.pdf.

Monahan, T. (2000). Built pedagogies & technology practices: Designing for participatory learning. In T. Cherkasky, J. Greenbaum, P. Mambrey, & J. Pors (Eds.), *Proceedings of the Participatory Design Conference.* Palo Alto, CA: CPSR. Retrieved from http://publicsurveillance.com/papers/pdc2000.pdf.

Monahan, T. (2008). Picturing technological change: The materiality of information infrastructures in public education. *Technology, Pedagogy and Education, 17*(2), 89–101. https://doi.org/10.1080/14759390802098581.

Morgan, D. (2004). Focus groups. In S. Hesse-Biber & P. Leavy (Eds.), *Approaches to qualitative research* (pp. 263–285). New York, NY: Oxford University Press.

Mulcahy, D., Cleveland, B., & Aberton, H. (2015). Learning spaces and pedagogic change: Envisioned, enacted and experienced. *Pedagogy, Culture & Society.* Advanced Online Publication. https://doi.org/10.1080/14681366.2015.1055128.
Ryan, M. (2011). Spaces of possibility in pre-service teacher education. *British Journal of Sociology of Education, 32*(6), 881–890. https://doi.org/10.1080/01425692.2011.614745.
Silverman, D. (2005). *Doing qualitative research* (2nd ed.). London, United Kingdom: Sage.
Whyte, B. (2017). Collaborative teaching in flexible learning spaces: Capabilities of beginning teachers. *Journal of Educational Leadership, Policy and Practice, 32*(1), 84–96.

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Hack the School: A Creative Toolkit to Transform School Spaces

Sílvia Sasot and Esther Belvis

Abstract The 'Hack the School' project provides school communities a guided experience to support the transformation of their learning spaces. The aim is to foster change through a comprehensive and co-creative approach facilitating the transition from traditional uses of space to innovative ones with the concept of wellbeing as primary agency. A conceptual framework based on seven principles—welcome, belonging, communication, cooperation, diversity, movement and transduction—and an applied creative toolkit equip the process and provide a unique and novel perspective to the topic of innovative learning environments. Thus, the project channels the emerging needs regarding educational spaces challenging the current regulations that the public administration applies in Spain and initiates a dialogical collaboration between the field of education and architecture. The challenge open to all schools and funded by the Jaume Bofill Foundation received over 170 proposals in the Catalan context, where 30 schools were selected and are now becoming effective 'hackers'.

Introduction: Schools, Spaces, Trends and Legislation in Spain

Innovation trends in education often embrace a 'frantic change' approach which is mainly associated with improved performance and constant adaptability to change. In this innovation paradigm where production and efficiency support emerging ideas, education space transformation in Spain has been restricted and mainly associated with the incorporation of information and communications technology (ICT) (Adell & Castañeda, 2012). However, although ICT can be conceived as a trigger for many emerging challenges in education, the truth is that educational improvement involves

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a conglomerate of interrelated aspects well beyond ICT, and all need to be considered and addressed. Current emerging pedagogies focus on the search for optimal methods and formulas to respond to the standards proposed by the educational systems and other international bodies, such as the Organisation for Economic Co-operation and Development (OECD). The OECD's seven principles of learning have become a key driver for the introduction of the concept of innovative learning environments (Hanna & David, 2013).

Despite the value of those principles and their significance in establishing new approaches for both practitioners and policy-makers, the fact is that the conceptualization and possibilities for innovative learning environments (ILE) are subjected to a myriad of contextual needs and regulations. There are deep patterns of thinking related to traditional educational buildings design: classroom, corridors, table-chair, teacher desk, teacher room, etc. There is a need to observe and problematize, both subjectively and objectively, the patterns of thinking that go into designing school buildings and educational spaces (particularly in Spain where the issues related to school architecture are often quite conventional). Rather than responding to diversity, the predominant paradigm of school building design trends towards homogenization (see catalan regulations for designing Public Schools: http://ensenyament.gencat.cat/web/.content/home/departament/publicacions/monografies/criteris-construccio-edificis-centres-publics/criteris_construccio_edificis_centres_docents_publics.pdf).

A Variety of Needs?

In Spain the government has stipulated institutional categories that must guide the design of educational sites. This includes regulations on the types and sizes of spaces that should be included in a building. When the government regulates school architecture to this degree, it is hard to achieve diversity of approaches, as government requirements become the norm. From an objective perspective, and in order to steer away from homogenization, it is necessary to explore the key aspects of learning environments from a wider perspective.

In the current system in Spain a blueprint is provided to the designers which defines the measurements of classrooms and resembles a factory design (production) rather than a community design (co-living). Architects receive an official drawing with rows of chairs looking at the blackboard as a recommendation from the document 'criteria for the construction of new buildings for public educational centers'. Only 'productive' spaces are considered, i.e. where one teacher leads one group of students; shared areas and community spaces are not considered. The regulations have been revised only twice since the Spanish Constitution was signed in December 1978 (March 2010 and June 1991), but these still reflect the political concerns of the Spanish Transition 1975–78, and Franco's dictatorship. It is appropriate now that school design changes from one based on a conceptual framework grounded in a productive-technical approach to one that considers wellbeing, pedagogy or community and includes all educational stakeholders. The weight of tradition both within the architectural profession and in the Spanish government regulation presents significant challenges for change, but there is growing recognition in Spain of the importance of meeting the needs of the school communities and including them in the design process. When the inhabitants of educational facilities are excluded from the design process, the site only represents the vision of the designers, educational managers and government.

Local Input

The project Hack the School (see website: http://bit.ly/2h3p2QY) emerged in a context where out-of-date regulations govern education and where learning communities are striving to take responsibility of their own spaces and to explore and develop new innovative pedagogies. In this regard, it is important to note that the project stands for the empowerment of schools by providing not only a set of resources and experiences but also by triggering a network of knowledge exchange among the different participant centres in Catalonia. This paper presents both the interrelated conceptual framework and implementation of the project, giving evidence of how learning by doing is one of the most effective ways to intervene and raise awareness about the potential of our current learning environments.

Hack the School Open Challenge

The Hack the School project funded and coordinated by the Jaume Bofill (JB) Foundation is set up as an open challenge for the transformation of educational spaces. All schools and high-schools in Catalonia are invited through a public open call and communications campaign coordinated by the JF Foundation. The idea is to "hack" one school space by developing a micro-project using the resources available for creating a prototype of the possible change. More than 170 schools and high-schools responded to the call, and from those, 30 were selected to apply the Creative Toolkit (see Creative Toolkit: https://www.fbofill.cat/sites/default/files/Guia_hacktheschool_200217.pdf; see website: http://bit.ly/2h3p2QY; see website: http://bit.ly/2fkQ9Dr) and participate in Hack the School activities organized by a committee of experts in the field of education and architecture. The JB Foundation also looked for volunteer architects and designers willing to participate in the call with the support of FAD (Fostering Arts & Design—Design Hub Barcelona).

The project includes the following actions:

Introductory Workshop: An open free workshop organized to introduce the Creative Toolkit and the key concepts of the Hack the School framework, taking place at the Museum of Contemporary Art of Barcelona (MACBA).

Matching Workshop: Selected schools and high-schools participate in a matching workshop where they meet their volunteer supporting architects and are introduced to the Hack the School Creative Toolkit and Process.

Hack the School Implementation: For three months each school and high-school autonomously apply the Creative Toolkit and participate in a range of activities. These include visits to other schools that had been previously transformed, workshops led by architect professionals and creativity workshops carried out in the Museum Centre of Arts Santa Mònica.

Social Media: The Creative Toolkit and JB Foundation promote the interaction among the participants. Moreover the Creative Toolkit aims to share the results of the key moments of the process.

Results & Prizes: Each of the centres is asked to present a report on the results and two specific activities from the Toolkit; including the main aspects of the micro-project developed and a reflection on the main learnings. The six best projects are recognized with awards and a final event is organized where all the centres have the opportunity to share ideas and projects.

Reframing Innovative Learning Environments Through Wellbeing

Hack the School utilises current regulations and constraints, and explores the possibilities to overcome them through creativity and co-design. The Creative Toolkit is designed to foster a series of micro-projects in the different school spaces using an interdisciplinary approach. The toolkit aims to help communities improve learning conviviality through a process that uses design-thinking techniques. The toolkit has three parts; a conceptual framework, methodological tips and the creative process itself based on a series of activities.

The conceptual framework is based on the three core aspects; wellbeing, environments and pedagogies. Often the understanding of innovative learning environments approaches the intersection of spaces, technologies and methodologies (Fig. 1).

However, as designers of the toolkit, we feel it is important to go one step further and reconsider this relationship by including a comprehensive conceptual framework that goes beyond the technicalities of each discipline (architecture and education). Using the umbrella of ‘wellbeing’ allows this, and drives reflection and performance towards a more holistic comprehension of the ILE. To support this framework, seven operational key criteria are included. The seven criteria—welcome, belonging, communication, cooperation, diversity, movement and transduction—serve to visualize the transformation possibilities of the spaces while enhancing a new culture of learning and community creation, widely promoting the global development of children and young people and providing a satisfactory and healthy working environment for the education professionals (Fig. 2).

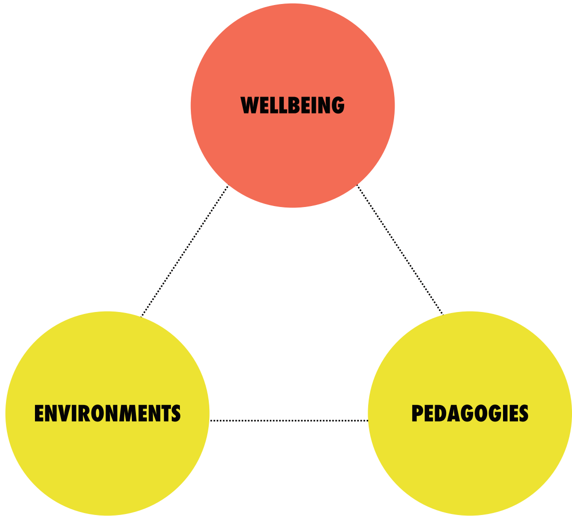

Fig. 1 Hack the school conceptual framework

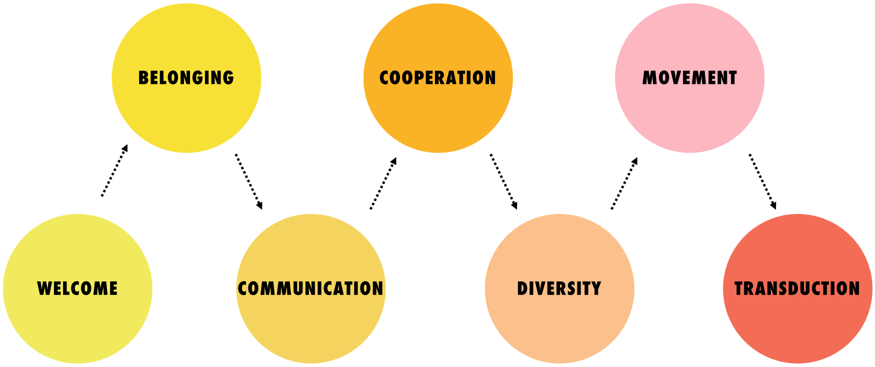

Fig. 2 Hack the school seven operational criteria

This framework serves to sustain the Hack the School process and the design of the Creative Toolkit and helps to foster changes that empower communities, so they can lead transformation on their own and attend to their particular needs. As said, the Creative Toolkit firstly explores the conceptualization and gives methodological tips to address learning environments transformation. It uses a design-thinking approach; its foundation is inherently practical. The toolkit does not aim to 'academically' educate communities, but rather fosters a learn-by-doing focus. The creative toolkit then presents a range of activities that are structured in four creative phases: Starting, Discovery, Co-creation and Assessment.

As Fig. 3 shows, the two first phases, Starting and Discovering, aim to create bonds and reflection among the members of the educational community, while the second focuses on the creation of the prototype and the implementation and assessment of

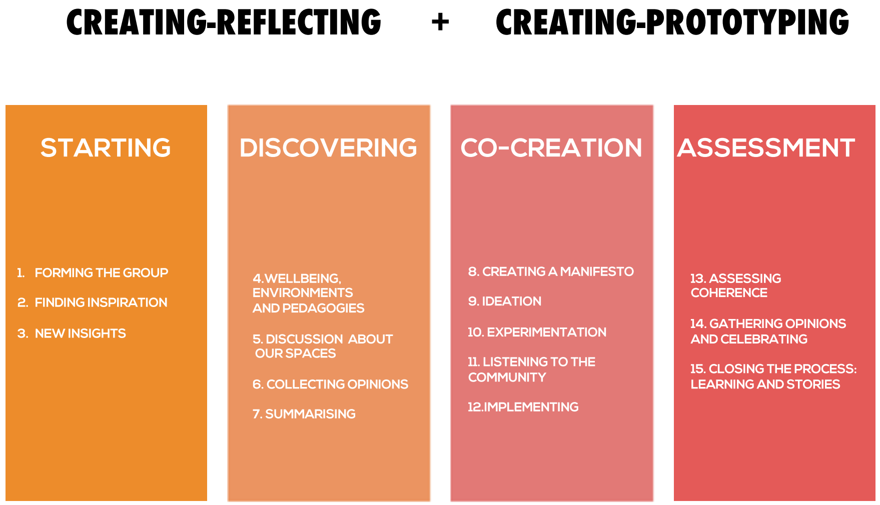

Fig. 3 Creative phases

it. The different activities aim to involve the entire community and widely integrate their interests and expectations, so the goals and outcomes become imagined, shared and celebrated by the whole community.

Outcomes and Conclusions

The outcomes of this project can be considered extremely positive. On one hand, all the centres selected participated actively in the different activities proposed throughout the process and shared on social media their questions ideas and progress. The use of the Creative Toolkit was uneven among communities, depending on their level of autonomy and experience in these kinds of processes. However, most of them stated that the Creative Toolkit guided the process and triggered inspiration to create and invent their own participatory activities, ways of working or sharing ideas. As the Farigola School stress in their final report, the comprehensive nature of the experience is one of the project's most valued aspects; including the conceptual approach, the process of implementation, the active participation of all the school community and the possibility to open and close a specific cycle of discovery and change. Hack the School has provided: a toolkit full of resources, tools and ideas, training, internal and external engagement through dissemination activities and motivation for involvement linked to the prize. Innovation has emerged in different ways and across groups and community members. In this regard, we can argue that the process served to overcome resistance to change and empower educational centres.

Moreover, this change of attitude enhanced further changes in each school and high-school despite the limitations of law, and encouraged other centres to use the Creative Toolkit on their own.

> As a school we have always been very concerned about the concept of space and its distribution and aesthetics, as we have hoped for a warm and welcoming school for children and adults as they spend many hours daily. It is true that we have taken care of this aspect at a classroom level, looking for a shared approach but under the responsibility of each year tutor. Common spaces such as corridors, art classrooms, carpentry and dining room are always to be re-planned due to lack of time and human and economic resources. However, we were aware that they needed a change. The fact of participating in the Hack the School project opened a new interesting horizon of time and resources to be able to think how to face this change (Headmaster, Nou de Quart School).

For many schools, the call served as a motor for change; a way to address pending changes related to spaces transformation, but also to other aspects such as conviviality and the school's educational approach. In this regard, the relationship between the architects and the educational communities served to open discussion in the public sphere about established tradition and promoted an in-depth understanding of how educational methodologies and school spaces are the backbone when it comes to foster wellbeing. As one of the participant architects points out:

> Participating in Hack the School appealed to me from different points of view. It has been an opportunity to learn and be able to share with others experiences and knowledge in the fields of education, design and art. Moreover, it is a project where you work with an intergenerational human team, and with professionals from different fields. The desire for new challenges and learning has led me to participate and get involved in this experience.

In the specific context of Catalonia, this fact links with the willingness of many teachers to change methods in order to accommodate diversity and experiment with innovative ways of learning. Implicitly, changing their spaces became the trigger to rethink education, including the implementation of new methodologies and the principles attached to those such as collaboration, horizontal learning and inclusiveness, those clearly related with the OECDs seven principles. It was also interesting how collateral educational topics emerged, such as gender issues; in some of the schools that worked on changing the playground, students raised gender issues regarding territory, privilege and diverse use needs.

> At a pedagogical level, I think it is important that we keep on reinforcing the collaborative group among students, taking into account gender issues too. When working in small mixed groups, often boys and girls felt frustrated. They stated the present of many stereotypes when it comes to play, considering sports something for boys and crafts more for girls. I think it is a good moment to incorporate a co-educational perspective, taking into account that the school is thinking in changing its methodology (Teacher comment).

The project reinforced communication and engagement at many levels; as some teachers mentioned, their students gave them ideas of how to become better educators, or how to provide ideas for experimentation. In this regard, the project helped leave behind a model based on single classroom education, and fostered a positive attitude of students towards the school. Some of the comments included: 'It has been so much fun'; 'what has surprised me the most is that we have been able to change the school and that we are going to be able to work properly in the future'; 'I have participated actively in this project because I wanted to help to change and improve our school'.

The project has seen strong commitment by students, indicating participation and autonomy have an impact on conviviality and the sense of belonging. Thus, the school was perceived as site full of possibilities and open to all. Now, any space can be used for educational purposes, in formal and informal ways. It was surprising to see how in a climate such as ours in Catalonia, schools did not use outdoor spaces which have been traditionally used only for play-time. This reconceptualization of the space had an impact on the school organization. In general, changes provided 'more sense' to the way teachers and families want to educate their children. One of the challenges is '*to unlearn the names for furniture and objects and see them for their characteristics and potentiality instead of their associated functionality*', says one of the architects.

To conclude, the project can be understood as a facilitator of change, and its Creative Toolkit the strategic guide to make it effective. Of course, results did not follow a concrete pattern or standard; but the idea from the very beginning was to help participating schools and high-schools to find their own identity, using this space transformation as a trigger. Hack the School involved the creation of a stable space for reflection, discussion and contribution to the emerging educational issues, taking into account the equal and horizontal participation of teachers, families and students. In this regard, many of the participants stressed that besides the improvement of spaces, the project has had significant impact on communication as the project produced and reinforced channels of communication (social media, panels, meetings, etc.) among all the school community. As Canigó school reports the project enhanced '*the creation of a network, which has brought us together and has proved that together we can do more things and in a better way. Now families see that they can propose activities to the school*'. Although the project focuses on the transformation of spaces, the schools agree on the fact that the process might be applied to other projects and topics. In general schools and high-schools valued the fact that the project had not only an impact on the school dynamics and life, but also the development of skills related to leadership and management among the students and among teachers and families—a shared empowerment.

One year after the experience, the JB Foundation did a review of the participating centres. In general, all the schools maintained the changes, totally or partially. On some occasions, the period of transformation of the spaces was considered a long term effort, which meant that they now expect to complete the project in three or four years. Other centres continue to involve families and students in the concretion of proposals, so changes respond to their needs. In this case the rhythm is slower though more participative—it reinforces the concept that good change is often a gradual, rather than immediate, action (Imms, 2018). As for the actors and their involvement, we see that more than half of the centres confirm that they have consolidated a group to work on additional tasks and that the call has been key to incorporating other stakeholders from the educational community that previously did not participate in the pedagogical debate. Hence, for the participating centres the project constituted the first milestone in the process of changing the school educational paradigm. This change marked a starting point in shared responsibility for the centre's educational performance and the importance of this among all the stakeholders. As one headmaster stressed, 'Hack the School has provided a collaborative working model in which each person brings the best of himself to achieve shared goals'. Hence, we might say that the 'Hack the School' experience allows us to say that although architectural regulations are restrictive and outdated in Spain, those 30 communities have been able to overcome them in only three months.

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References

Adell, J., & Castañeda, L. (2012) Tecnologías emergentes? pedagogías emergentes. *Tendencias emergentes en educación con TIC* (pp. 13–32).

Departament dÉnsenyament. (2016). *Criteris per a la construcció de nous edificis per a centres docents públics*. Retrieved from http://ensenyament.gencat.cat/web/.content/home/departament/publicacions/monografies/criteris-construccio-edificis-centres-publics/criteris_construccio_edificis_centres_docents_publics.pdf.

Fundació Jaume Bofill. (2017a). *Hack the school - La veu dels protagonistes del canvi*. Available from http://bit.ly/2h3p2QY.

Fundació Jaume Bofill. (2017b). *Com dissenyar espais educatius per aprendre i conviure?* Retrieved from https://www.fbofill.cat/sites/default/files/Guia_hacktheschool_200217.pdf.

Hanna, D., & David, I. (2013). OECD (Eds.). *The nature of learning: Using research to inspire practice, 2010*. OECD Center for Educational Research and Innovation Ed. The nature of learning from the utilization of research to implementation. Tokyo: Akashi Publishing.

Imms, W. (2018). Innovative learning spaces: Catalysts/agents for change, or 'just another fad'? In S. Alterator & C. Deed (Eds.), *School space and its occupation: The conceptualisation and evaluation of new generation learning spaces* (pp. 107–118). Amsterdam, The Netherlands: Sense Publishing.

Law Nº 34. Boletín Oficial del Estado (Spain)1971.

Law Nº 14054. Boletín Oficial del Estado (Spain) 1978.

Law Nº 16419. Boletín Oficial del Estado (Spain) 1991.

Law Nº 4132. Boletín Oficial del Estad (Spain) 2010.

Silvia Sasot and Esther Belvis (Spain) are both professionals and university lecturers interested in the intersection between education, creativity, architecture and the arts. Silvia Sasot is an architect specialized in learning environments who works directly with school communities designing their spaces linked to their pedagogy. Esther Belvis is an art director and pedagogue who designs forefront strategies, crafts meaningful experiences, devises resilient content and designs disruptive action plans to inspire and boost social change.

Conclusion

Where to Now? Fourteen Characteristics of Teachers' Transition into Innovative Learning Environments

Wesley Imms and Marian Mahat

Abstract This chapter places the preceding papers into a wider context. As part of the Innovative Learning Environment and Teacher Change (ILETC) project, seven Transitions symposia were held in five cities across Australasia, Europe and North America during 2017, 2018 and 2019. Each aimed at investigating how teachers adapt to innovative learning environments. The resulting accumulation of approximately 150 papers by graduate researchers and research groups, of which this book's chapters are a sample, constituted a reasonable representation of international thinking on this topic. When added to three years of ILETC case studies, surveys, systematic literature reviews and teacher workshops, the project team was able to identify consistent patterns in teachers' spatial transition actions. This chapter places the material of this book within that larger picture, specifically in terms of one project output—the development of a Spatial Transition Pathway. The Pathway emerged from these data and can be seen as an output of the material sampled in previous chapters. Certainly, the considerable work teachers had been doing to re-conceptualise their pedagogies for new spaces (done both intentionally, and at times, without realising) deserved to be mapped as a resource for others undertaking this journey. This chapter makes the case that while each teacher or school's journey from traditional to 'innovative' spaces is unique, there exists some common issues that most seem to face at some time, in some way. It provides a description of fourteen 'grand themes' that appear commonly through the data and describes how these can be organised in a way that provides temporal and theme-based strategies and tools, developed by fellow educators to assist in this transition. This final chapter leads the reader to consider 'where to now'? It celebrates the fact that teachers have enormous capacity to work out how to utilise innovative learning environments well and provides a framework for evidence-based actions into the future.

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Context

The consistent messages from the preceding chapters are as follows: innovatively designed spaces, intended to broaden the skills developed by all students, now exist in reasonable numbers. Like much innovation, they are a creation and development of an idea—more a work in progress than a proven solution. For 'success' they require consistent, focused, well-supported actions by designers, administrators, teachers, students and parents over a period of time; the suggestions of success they provide warrant sustained effort. In short, we are all participating in the practice of iteration—we are building success from success and learning from what does not work as well.

Research, the generation of new knowledge, is a critical part of this process. However, it is also a proven process of development; through applied research, we plan and implement strategies, we gather robust data on what occurs, we analyse logically, report findings in a range of ways, then use that to conceptualise the ways we need to proceed in the future to attain sustainable success. This process means every now and then we must nail our colours to the mast. We declare 'this is what we now know' and encourage our findings to be used so we can progress to another layer of analysis and development.

This then is the context for what follows in this final chapter. The increasing body of research on use of innovative learning environments as sampled in this book's chapters has been collated into a framework for actual use. The chapter will briefly overview the analysis methods that lead to the Pathway design (briefly, because a comprehensive account is being made available elsewhere). It will focus in more detail on the actual structure of the Pathway and conclude with an example how it might be used. This is iterative design; utilisation of the resource is to follow.

Developing the Transition Pathway

As one example of the extent of investment in innovative learning environments, Australia has seen over $16B invested in school buildings over the past nine years (Commonwealth of Australia, 2010). It is estimated Australia alone needs to add about 750 new schools to meet a growing population (Goss, 2016). This need is creating an infrastructure investment of up to AUD$11B (Holland, 2017), the total of this investment is considerable for a country of about 25 million people. Much of this investment is in what are called innovative learning environments, flexible and purposeful designs driven by a national policy to foster graduates who can excel at twenty-first-century thinking. How do we move from developing graduates who can perform routine tasks well, to those who have these skills but can also excel at interpersonal, non-routine ways of working? Australia, like many countries around the world, believes the design of schools plays some part in this. But it must be emphasised—this investment is not about the buildings, it's about what happens in those spaces.

Project ILETC's wish is to better understand how these innovative learning environments improve student learning experiences. In this project, we unapologetically focus on teachers. We know that good teaching is the single largest influence on improving student learning (Hattie, 2009, 2012). ILETC wants to help good teachers teach even better. One way of doing this is by building evidence and resources that help them realise that learning environments like these can be a vital, key part of their pedagogical repertoire.

So, by 'student educational experiences' we mean improving measurable learning outcomes, but even more critically we look to the development of those qualities considered vital when equipping our students to do well in a rapidly changing society: collaboration and communication skills; creative and critical thinking skills. Our belief is that these are qualities that are developed effectively within the phenomenon of student deep learning (Mahat, Bradbeer, Byers, & Imms, 2018).

And by 'helping teachers teach better' we look to those mind frames that teachers utilise when they engage in practices seen to have the greatest effect on quality learning outcomes for students. There is a difference between an experienced teacher, who knows what to do, and an expert teacher, who maximises student learning. Research shows the latter occurs when a set of ways of thinking are employed—the mind frames (Hattie, 2012; Mahat et al., 2018).

So, we would like you to keep these two concepts at the forefront of your thinking as you read further, because ILETC is situated at the intersection of student deep learning, teacher mind frames and the potential of innovative learning environments.

What Did We Do?

We began by gathering baseline data that has been presented within a myriad of ILETC publications since 2017 and is selectively cited in this chapter and available online at the project's website. The baseline data was required for a number of reasons, but the critical ones were to: firstly gauge the current state of play, and second to test assumptions we carried to the project. Let us focus on the first of these.

What innovative learning environment infrastructure actually exists in Australia and New Zealand? No one, including the large education departments partnering us in this research, could answer that seemingly basic question. Our problem was, how can we suggest ways to help teachers transit into innovative learning environments if we don't know how many exist and in what configurations?

We used The University of Melbourne's Learning Environment Applied Research Network (LEaRN) Typology of Spatial Design[1] (Fig. 1) to ask this question to over

[1]This has been developed over time through various LEaRN projects, but acknowledgement must be made to Drs. Kenn Fisher and Kym Dovey for the original conceptualisation; Dovey, K. & Fisher, K. (2014). Also to Dr. Pippa Soccio for the graphic representation.

Fig. 1 Typology of spatial design (*source* Imms, Cleveland & Fisher, 2016. Reprinted with permission from the ILETC project)

a thousand primary and secondary school principals in Australia and New Zealand, discussed briefly in Kenn Fisher's introductory chapter. The left-hand side of the typology identifies traditional cellular classrooms, what we call Type A. The right-hand type identifies open plan classrooms, what we call Type E. Between are a set of hybrid types between these two apparent extremes. Results from this first large ILETC survey showed that approximately a quarter of existing teaching spaces in Australia and New Zealand were Types C, D and E, what we'd consider more innovative spaces. The rest were traditional classrooms, some with an adjacent common area.

What types of pedagogies are being employed in these spaces? Again, LEaRN developed a typology showing six types of pedagogy ranging from a traditional teacher-centred approach with tables arranged in rows facing a front, to a pedagogic approach that encouraged students working totally independently with little or no teacher interaction (Fig. 2). What we found was that according to principals, 75% of teachers in their schools were teaching didactically through teacher-centred instruction (Typology 1 and 2). So, at any given time in Australia and New Zealand, 75% of students are arranged in traditional settings, facing the front of a room with a teacher talking to them.

We also asked principals what type of learning was happening, and for this we used a scale based on Biggs' surface-to-deep learning characteristics (Biggs, 1987).

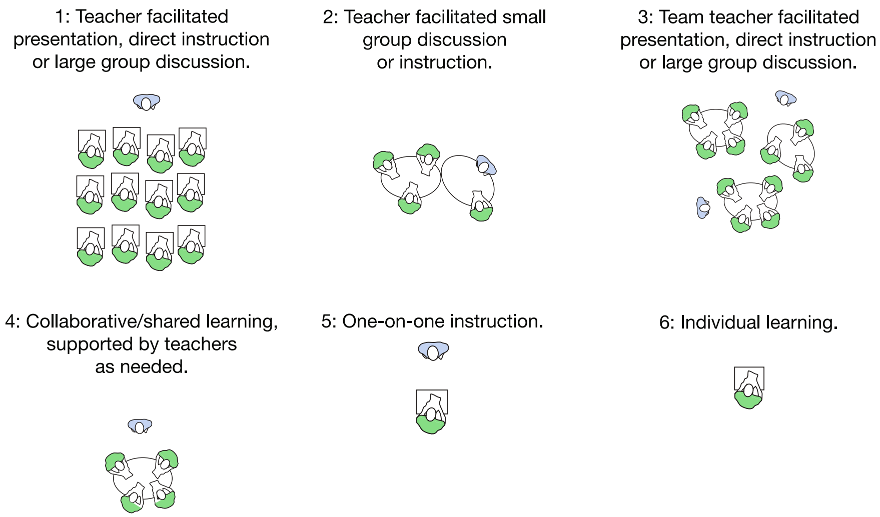

Fig. 2 Typology of teaching approaches (*source* Imms, W., Mahat, M., Byers, T, & Murphy, D. 2017. Reprinted with permission from the ILETC project)

This was extended to principals' belief about the qualities evident in that teaching, based on Hattie's visible learning work that produced eight 'mind frames' characteristic of high-impact teaching (Hattie, 2012).

When correlated to the types of spaces in use, we identified a direct and clear trend (Fig. 3); low-impact teaching strategies and surface learning were consistently correlated to traditional classroom designs; high-impact teaching and good deep learning characteristics correlated strongly to Type D and E designs.

This survey is reported in an ILETC Technical Report, available online (Imms, Mahat, Byers, & Murphy, 2017; Mahat & Imms, 2020). As too are an additional four 'baseline data' strategies we utilised in that first phase of the project. Apart from Principals' perceptions,

- we asked teachers what they believed about innovative learning environments, using design thinking strategies to structure regional workshops across Australia and New Zealand (Mahat, Grocott, & Imms, 2017);
- we conducted three Prisma systematic reviews of literature to find out what range of research informed our issue (Bradbeer, Mahat, Byers, & Imms, 2019; Byers, Mahat, Liu, Knock, & Imms, 2018);
- we conducted over 30 case studies in schools by our team of seven Ph.D. students, to gain a more objective view of what was happening (see for example, French, Imms, & Mahat, 2019; Young, Cleveland, & Imms, 2019);
- we ran seven research symposia in Australia, New Zealand, North America and greater Europe to determine what is occurring beyond our shores (Imms & Mahat, 2017, 2018a, 2018b, 2019);

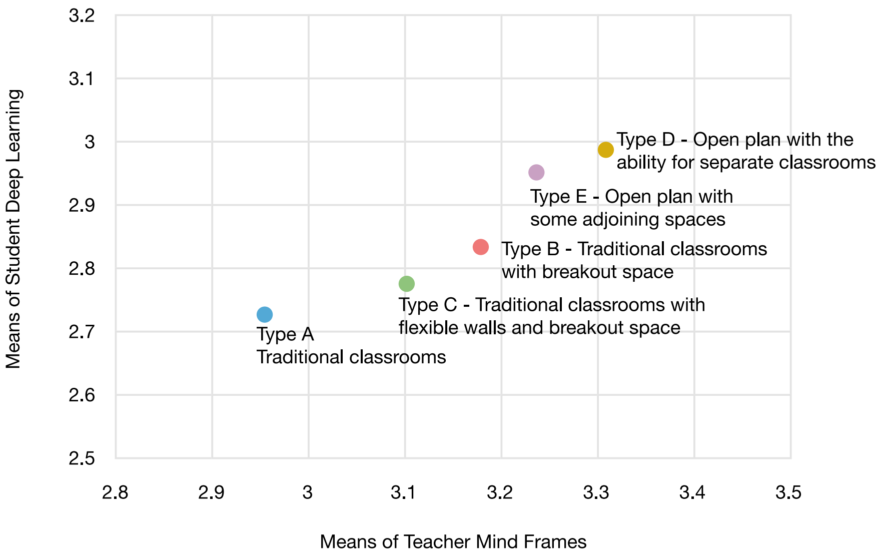

Fig. 3 Means of teacher mind frames and student deep learning categorised by most prevalent learning environment type ($n = 822$) (*source* Imms, W., Mahat, M., Byers, T, & Murphy, D. 2017. Reprinted with permission from the ILETC project)

– we conducted industry think tanks in the United States, Australia and England to get a sense of what associated industries believed was occurring (ILETC, 2018).

The Fourteen Grand Themes

The resulting mass of data collected over a 24-month timespan was analysed for a number of purposes, but a critical one was what we'd now like to focus on for the remainder of this chapter.

What characterises good teacher transition into innovative learning environments?

The first finding was the temporal nature of teacher transition to innovative learning environments (Fig. 4). This was not surprising—solid literature on this topic has consistently argued that teacher use of *innovative learning environments* is not immediate—it takes time for changes to occur (Bruckner, 1997). ILETC's Spatial Transition Pathway acknowledges this phenomenon and refines it further (Mahat et al., 2019);

– Good transition begins with what we call an early stage where teachers develop knowledge about the upcoming build and conceptualise how they should use it.
– Then comes an occupation stage, that magic period where everything is new, but also a challenging stage where the reality of these quite different environments is made stark.

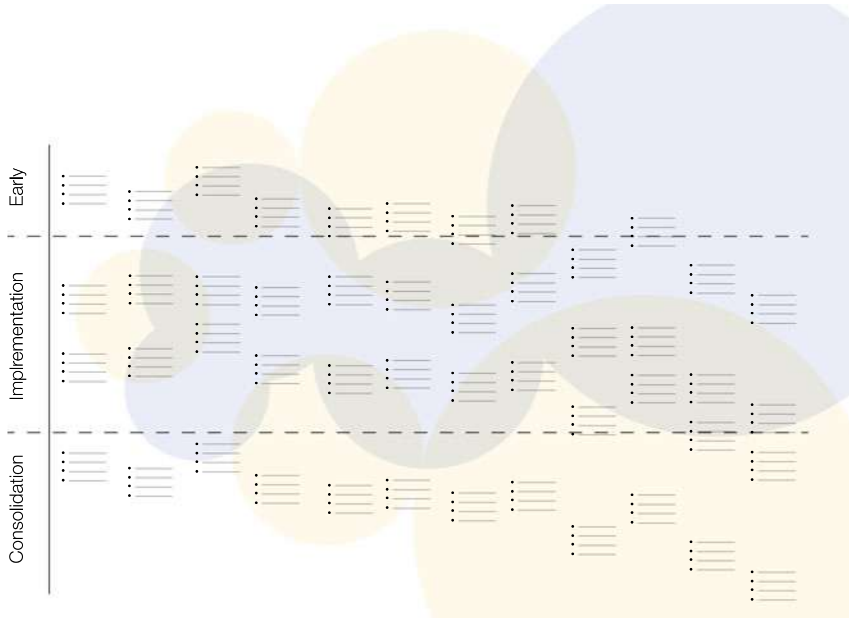

Fig. 4 The transitions pathway, *Y* axis denoting temporal aspect (Copyright the ILETC project)

– Finally, we have the longer-term inhabitation stage, the many years of use that prove—through experience—if the spaces are meeting the educational vision that brought them into being.

Across these stages our Phases One data allowed us to identify fourteen common characteristics of good transition, what we call out transition grand themes (Fig. 5). We describe these 'grand themes' below although the discussion within is non-exhaustive.

Teachers need TIME to (Mahat et al., 2017)

– Assist in conceptualising new spaces—providing an educational brief that informs the design brief
– Prototype new spatial arrangements
– Experiment with new pedagogies
– Trial collaborative teaching strategies
– Understand what the plans 'mean'.

Teachers need support in working out how old and new TECHNOLOGIES can support their teaching in these spaces (Mahat et al., 2017).

– Help to understand what exists at present—what are the technologies
– Support in auditing what technologies are present in each of their teaching spaces
– Guidance in how these technologies enhance student learning.

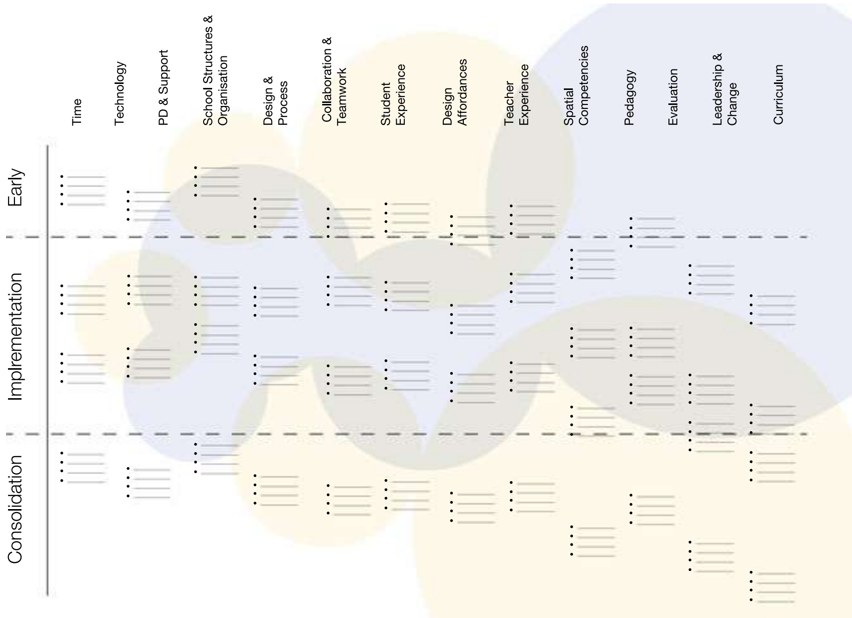

Fig. 5 The transitions pathway, with grand themes added (Copyright the ILETC project)

Teachers need PROFESSIONAL LEARNING (PL) on how to use these spaces well (Mahat et al., 2017).

- PL that is relevant to their existing knowledge and practices
- PL that address and extend their personal teaching philosophy
- PL that is feasible and useful given their schools' budgets and their own available time
- PL that can be put into action immediately
- PL that can be evaluated for impact against teachers' standards.

Teachers seek to improve their pedagogies in ILEs need the support of the STRUCTURE AND ORGANISATION of the school (French et al., 2019).

- Fostering a culture of growth, experimentation without judgement
- Allowing appropriate time for PD, that reflects the importance of supporting change

– Re-interpreting timetables that are adaptable to new ways of teaching
– Challenging subject discipline 'rules' to allow cross-disciplinary experimentation.

Teachers need to be active agents in the DESIGN PROCESS.

– Opportunity to express their vision for learning (the 'Education Brief').
– Seeing their ideas reflected in the preliminary designs (The Design Brief).
– Having the plans explained and discussed in ways they can understand.
– Establishing methods for implementation of their teaching into the proposed designs.
– Establishing ways to evaluate, across time, if the spaces are fulfilling their expectations for ideal teaching.
– Opportunities for re-design.

Teachers need support in developing visions for, methods of, and opportunities to refine effective COLLABORATIVE PRACTICES. Working together in spaces whether physical or virtual, we know that teachers need strategies to (Bradbeer, 2018)

– TEACH TOGETHER
– THINK TOGETHER
– simply BE TOGETHER.

Teachers need to understand the actual—as opposed to anticipated—STUDENT EXPERIENCE of inhabiting these spaces (Mahat et al., 2017).

– How do these spaces impact student well-being, relationships, feelings of worth?
– How do they foster inclusivity, including opportunities for participation for students with disabilities?
– How do these spaces assist improved student learning outcomes?

Teachers need help in seeing, then using, the anticipated and unanticipated AFFORDANCES of these spaces (Young et al., 2019).

– What did the designers 'build in' that will help quality teaching?
– How can teachers use these to their maximum?
– What of the accidental affordances, those elements that assist better teaching yet often remain unrecognised?

Teachers need support in the 'grammar' of spaces, how they work, and how they can work in these spaces. SPATIAL COMPETENCIES constitute to some degree a form of literacy and require nurturing (Leighton, 2017).

– Do I utilise all the spaces in my environment to their potential?
– Do I develop lessons that utilise space to enhance students' learning experiences and learning outcomes?

Teachers need support in developing PEDAGOGIES that reflect, utilise and leverage off the unique features of their learning space.

– What is the myriad of approaches available to teachers regarding collaborative practices?
– How can teachers continually evolve, refine, evaluate effective practices in these more flexible, ephemeral spaces.

Teachers need support to EVALUATE the way their use of space impacts student learning.

– Are students doing better or worse than the 'norm' in this environment?
– How do I understand which component of space is having what effect on student learning experiences?
– How can I monitor 'tweaks' to my approach to teaching, to understand what should be developed more, what should be modified?

Teachers need to experience good LEADERSHIP; support for the changes inevitable in good transition to ILEs (Osborne, 2018).

– How can teacher-inclusion be built into the change process?
– How can teachers' epistemological beliefs be incorporated into a more 'collaborative' teacher structure?
– How can teacher voice be represented in the major decisions that are being made?

Teachers need to have their 'spatial opinions and beliefs' represented at the CURRICULAR level.

– If curriculum is the journey, what is the starting point, what is the destination? How does space impact this?
– How do students 'occupy' curriculum in the way they occupy space?

Not a Formula

Analysis of data gathered from international audiences at ILETC symposia allowed the research team to organise the themes according to when they appeared to most commonly be of relevance; from 'early' in the transition stages (placing those to the left of the Pathway), during 'implementation' of ILEs (situating these to the middle of the Pathway), and into long term 'consolidation' as transition seemingly becomes established, but needs to be continually interrogated (the right).

We argue this arrangement of common themes temporally organised (Early, Implementation, Consolidation), constitutes a common pathway (represented hypothetically in Fig. 6 by the diagonal dotted line). Most schools, and teachers in schools, undertake this type of journey across time, and in the process often engage with issues represented by the themes. We are very keen to point out, however, this does not suggest the existence of an assured formula for good teacher transition. In fact, the more eclectic journeys illustrated by the fluid lines in Fig. 7 represents more accurately the actual experiences of schools and teachers who transit into innovative

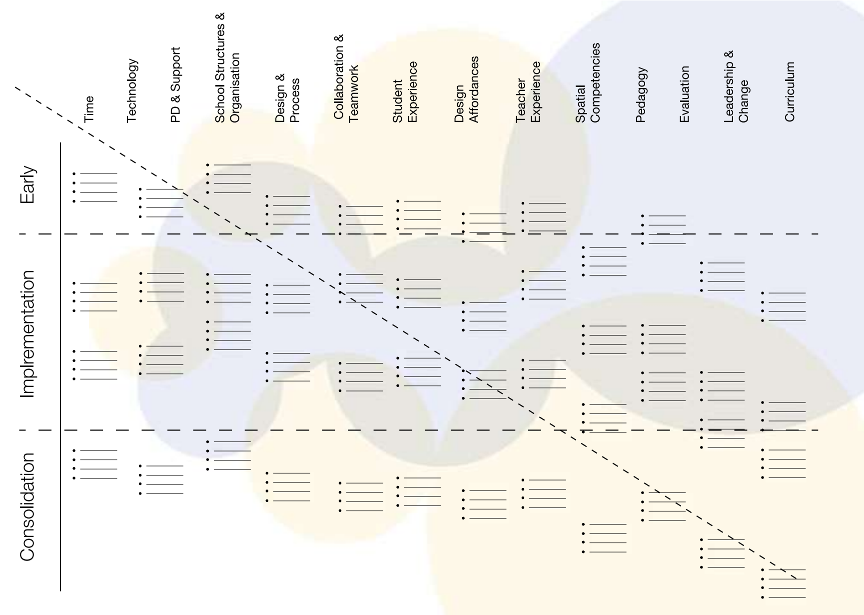

Fig. 6 The transitions pathway, with hypothetical common 'journey' indicated (Copyright the ILETC project)

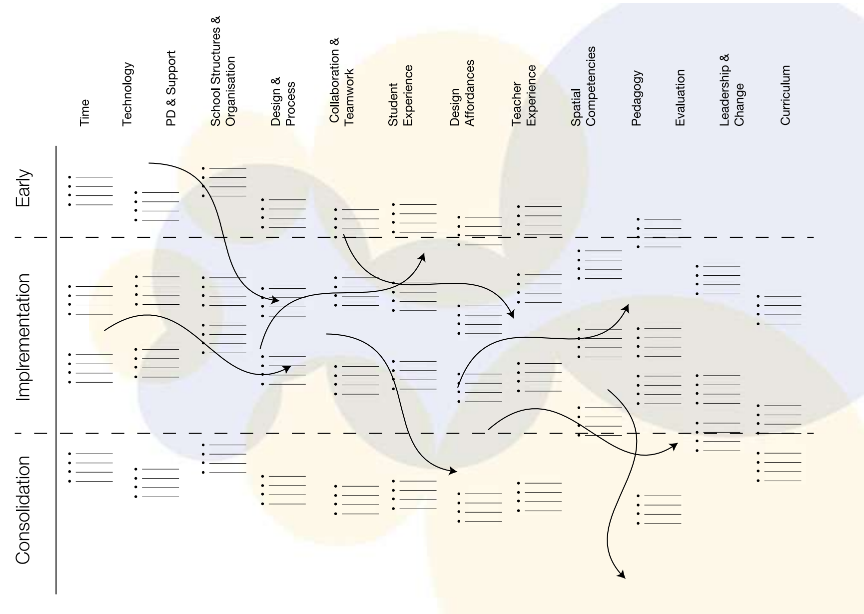

Fig. 7 The Transitions Pathway, with representative individual 'journeys' added (Copyright the ILETC project)

learning environments. Each starts at a different point and moves in a unique direction. Each has a unique set of needs and purposes. While the journey can be seen to be reasonably common, each school addresses unique spatial needs and each teacher implements often unique pedagogies to meet those needs. This is the reality of the ephemeral nature of modern schooling.

Populating the Pathway

We began this chapter asking how the papers in this publication give us direction for the ‘where to now’ question. These and other data sources gathered within ILETC have provided us with a framework for the way teachers are effectively moving into innovative learning environments. Our task now is populating this pathway with actual examples of good practices. Following the Transitions Symposia that was the source of this book, the ILETC team embarked on a complex data collection phase to find and document strategies schools and teachers had conceptualised to use innovative learning environments well, and the tools they built to implement those strategies. To illustrate, Figs. 8 and 9 provide a sample of this.

In this example, that of space and collaboration, schools identified three components—teacher/teacher collaboration, teacher/student collaboration and student/student collaboration (Fig. 8). To focus on the third, a common spatial

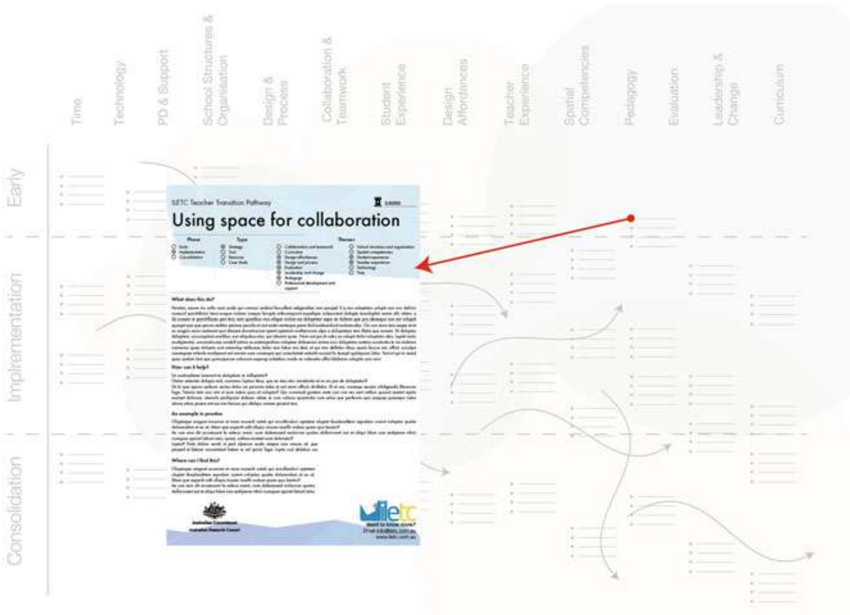

Fig. 8 The Transitions Pathway, with a sample ‘strategy’ indicated (Copyright the ILETC project)

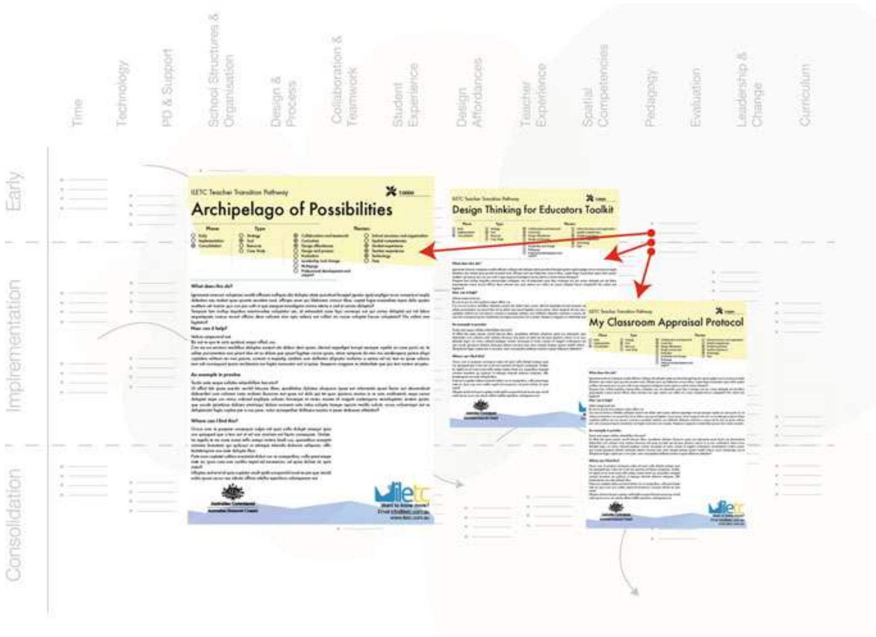

Fig. 9 The Transitions Pathway, with a sample 'tools' added (Copyright the ILETC project)

'problem' was that traditional furniture arrangements restricted this from happening. The reality was that time and effort required to rearrange tables and chairs to facilitate student/student collaboration meant teachers often avoided utilising this valuable affordance.

One 'solution' or a *tool* developed by some schools saw a simple diagram being placed beside the entry to the space with a number of arrangements graphically illustrated and given labels (Fig. 9). Teachers found that with a simple instruction ("Let's have type G") saw students quickly rearrange furniture in that configuration, and that was as easily reversed at the end of the lesson. The ILETC research team used data from the symposia to decide this spatial teaching strategy and tool was relevant during the implementation and consolidation stages of transition (the *Y*, or temporal axis), and best fitted to the Collaboration and Teamwork, Spatial Competencies and Student Experiences grand themes (across the *X* axis). It was, therefore, placed in that position in the overall Pathway—one of the myriad 'dots' shown in Fig. 7.

In this way, ILETC has been building the Pathway to organise many strategies and tools developed by teachers as they came to grips with the reality of transitioning into more innovative spaces. At the time of writing this book, the 'population' of the Pathway by documenting teacher practices is well advanced—a tangible, productive output from the theorisation, and applied thinking of the many researchers and teachers who contributed to ILETC.

Where to Now?

Assisting teachers to navigate the Pathway is the next challenge. As mentioned earlier, we know (1) that no school or teacher transitions from traditional to innovative spaces in the same way; and (2) often, teachers and schools are not always aware of the spatial components of their actions when seeking best practice; in short, few common spatial concepts are known, terminologies differ, and educators remain unaware of their own 'spatial competencies'. ILETC is now developing two methods of overcoming this problem; (1) a suite of activities or 'wayfinding exercises' that will help teachers understand what they do and don't know in terms of spatial knowledge and practices, and (2) a set of 'spatial typologies' (Fig. 10) that simplify difficult concepts such as types of furniture, acoustics and use of digital technologies in innovative learning environments, in a manner similar to the 'spatial design' and 'spatial pedagogies' illustrated in Figs. 1 and 2. These serve the function of assisting teachers to know what strategies and tools may meet their individual needs.

We would like to finish with a very positive spin from our research. We mentioned at the start of this chapter that the early stages of ILETC sought to understand what actually existed in terms of infrastructure and practices in those spaces. We feel we have a good grasp of that now.

The second objective was to test assumptions we brought to the project. For example, we believed we would need to design strategies and tools to help teachers transit into ILEs. That has been dispelled—our research is identifying a myriad of strategies and tools teachers have developed, either knowingly or unconsciously, as they make the most of their new spaces. These are now being documented and inserted into our Transitions Pathway. There may be gaps, and this forms an opportunity for future inquiry.

Another assumption was the assertion, commonly heard, that teachers were not using these spaces well. They were simply repeating old habits in new environments. The first survey challenged this assumption—the strong correlation between ILEs and high-quality teaching and good student learning demonstrated that good things were happening in these spaces. A second survey, due for publication in the near future, has provided evidence of what teachers were actually doing, their confidence in their skills to adapt to the new spaces, and their desire for particular support to assist this transition. The latter also validated the grand themes in the Transitions Pathway.

A Final Note

The realisation is that we must trust the competence of our teachers and provide them with the support they require to transit into these spaces. The Spatial Transitions Pathway is one way of doing this at the micro level, the actual practice of

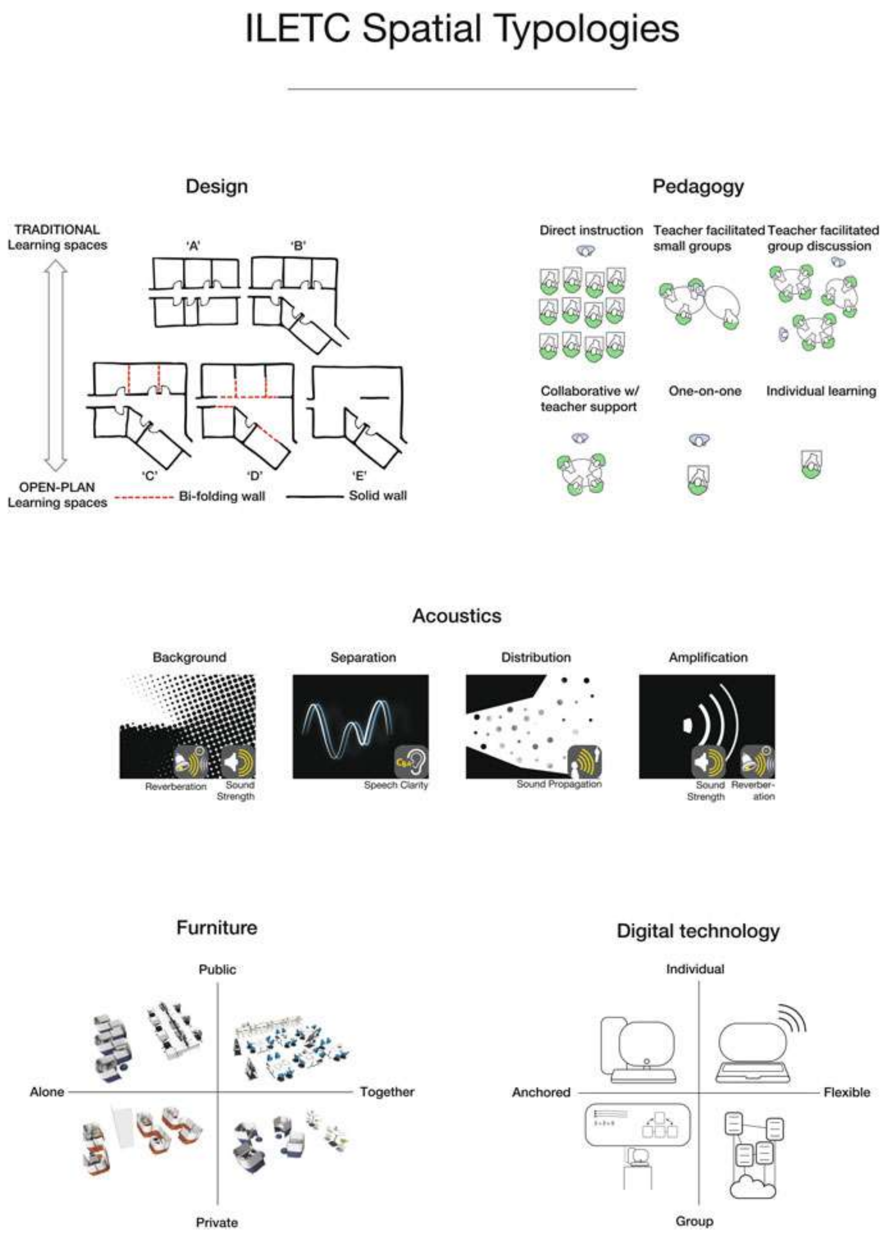

Fig. 10 The five spatial typologies (Copyright the ILETC project)

teaching in these spaces. However, in terms of the broader picture, we are challenged with a huge task in matching our dollar investment with teacher support. The latter is less visible, there are no shiny surfaces and beautiful vistas to show for that investment, but *how teachers actually use these spaces* will ultimately justify (or condemn) every penny spent. More research, such as shown in these pages by graduate researchers and talented early career researchers, is required. These buildings are, after all, predominately about the practices that occur within, and it is that knowledge that we must access.

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Further Reading

ILETC research outputs mentioned in this chapter (and upcoming outputs) are and will be available online. Requests for access are encouraged via this chapter's authors.

References

Biggs, J. B. (1987). *Student approaches to learning and studying*. Research Monograph. Australian Council for Educational Research.

Bradbeer, C. (2018). Enacting teacher collaboration in innovative learning environments. In W. Imms & M. Mahat (Eds.), *Transitions 2018: Continuing the Conversation, Proceedings of International Symposia for Graduate and Early Career Researchers in Australasia, Europe and North America*. http://hdl.handle.net/11343/227598.

Bradbeer, C., Mahat, M., Byers, T., & Imms, W. (2019). *A systematic review of the effects of innovative learning environments on teacher mind frames*. Innovative Learning Environments and Change. http://www.iletc.com.au/publications/reports.

Bruckner, M. (1997). Eavesdropping on change: Listening to teachers during the first year of an extended block schedule. *NASSP Bulletin, 81*(593), 42–52.

Byers, T., Mahat, M., Liu, K., Knock, A., & Imms, W. (2018). *A systematic review of the effects of learning environments on student learning outcomes*. Innovative Learning Environments and Change. http://www.iletc.com.au/publications/reports.

Commonwealth of Australia. (2010). *Building the education revolution*. http://web.archive.org/web/20100417041604/http:/www.deewr.gov.au:80/schooling/buildingtheeducationrevolution/Pages/default.aspx.

French, R., Imms, W., & Mahat, M. (2019). Case studies on the transition from traditional classrooms to innovative learning environments: Emerging strategies for success. *Improving Schools*. https://doi.org/10.1177/1365480219894408.

Goss, P. (2016, January 22). *Should you worry about a schools shortage? It really depends on where you live*. Conversation. https://theconversation.com/should-you-worry-about-a-schools-shortage-it-really-depends-on-where-you-live-53296.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analysis relating to achievement*. London: Routledge.

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. London: Routledge.

Holland, K. (2017, June 28). *Major crisis in Australian public school infrastructure.* Retrieved from https://www.wsws.org/en/articles/2017/06/28/infra-j28.html.
ILETC. (2018). *Phase one report 2016–2017.* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/wp-content/uploads/2018/06/ILETC-Phase-1-report-published.pdf.
Imms, W., Cleveland, B., & Fisher, K. (Eds.). (2016). *Evaluating learning environments: Snapshots of emerging issues, methods and knowledge.* Rotterdam, The Netherlands: Sense Publishers.
Imms, W., & Mahat, M. (Eds.). (2017). *Transitions Australasia: What is needed to help teachers better utilize space as one of their pedagogic tools.* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/proceedings/.
Imms, W., & Mahat, M. (Eds.). (2018a). *Transitions Europe: What is needed to help teachers better utilize space as one of their pedagogic tools.* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/proceedings/.
Imms, W., & Mahat, M. (Eds.). (2018b). *Transitions North America: What is needed to help teachers better utilize space as one of their pedagogic tools.* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/proceedings/.
Imms, W., & Mahat, M. (Eds.). (2019). *What are teachers doing (well) when transitioning from traditional classrooms to innovative learning environments?* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/proceedings/.
Imms, W., Mahat, M., Byers, T., & Murphy, D. (2017). *Type and use of innovative learning environments in Australasian Schools—ILETC Survey 1.* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/reports.
Leighton, V. (2017). Teaching space: Does a teacher's spatial competency affect their teaching and effect the different types of learning that takes place in a classroom? In W. Imms & M. Mahat (Eds.), *Transitions Symposium Proceedings Australasia 2017* (pp. 57–63). Innovative Learning Environments and Teacher Change. http://hdl.handle.net/11343/198087.
Mahat, M., Bradbeer, C., Byers, T., & Imms, W. (2018). *Innovative learning environments and teacher change: Defining key concepts.* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/reports.
Mahat, M., Bradbeer, C., Cattlin, J., & Imms, W. (2019). Validating the ILETC's teacher transition pathway. In W. Imms & M. Mahat (Eds.), *What are teachers doing (well) when transitioning from traditional classrooms to innovative learning environments?* (pp. 13–26). Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/proceedings/.
Mahat, M., Grocott, L., & Imms, W. (2017). *"In the real world…": Teachers' perceptions of ILEs—ILETC Phase 1 teacher workshops.* Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/reports.
Mahat, M., & Imms, W. (2020). Establishing a reliable measure of perceptions of teacher and student use of learning environments. *The Australian Education Researcher*. https://doi.org/10.1007/s13384-020-00382-z.
Osborne, M. (2018). Change leadership and the transition to innovative learning environments. In W. Imms & M. Mahat (Eds.). *What are teachers doing (well) when transitioning from traditional classrooms to innovative learning environments?* (pp. 157–161). Innovative Learning Environments and Teacher Change. http://www.iletc.com.au/publications/proceedings/.
Young, F., Cleveland, B., & Imms, W. (2019). The affordances of innovative learning environments for deep learning: educators' and architects' perceptions. *The Australian Educational Researcher* (pp. 1–28). https://doi.org/10.1007/s13384-019-00354-y.

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