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The 'why' and 'how' of flexible learning spaces: A complex adaptive systems analysis

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Abstract

This article presents the perceptions and experiences of 12 school principals, 35 teachers and 85 students on the influences and processes used by eight Australian government primary and secondary schools to transform traditionally arranged classrooms into flexible learning spaces. Characterised by a variety of furniture and layout options, these spaces are designed to enable a range of learning styles and activities and facilitate student-centred pedagogy. These changes to school learning environments are discussed in light of some central constructs of complexity theory, including inertial momentum, emergence, agent interaction, information flow, feedback loops and lock-in. The findings highlight the role of consultation, participation and ownership as central elements of sustainable change processes. Further effective design and transformation of learning environments requires a reflexive school community, pedagogical shift, professional development, and ongoing support to teachers and students. The discussion emphasizes the sociomaterial interplay between the pedagogical and physical classroom environment.

Keywords Complex adaptive systems · Educational change · Flexible learning spaces · Schools

Introduction

Schools across the globe are adopting contemporary pedagogical approaches and transforming their physical learning spaces to better meet the needs of 21st century students (Blackmore et al. 2012; Cleveland and Fisher 2014; Kuhlthau 2015; Mulcahy et al. 2015). Traditionally arranged classrooms featuring rows of desks and chairs are being replaced by a range of furniture items and layout options, in a relatively open space, which can be configured in various ways to facilitate a range of

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teaching and learning experiences. These spaces endeavour to offer opportunities for both individual and collaborative work, whilst utilising a range of technologies to facilitate personalized teaching and learning (NSW Government Department of Education 2015). A range of learning modes have been identified as enablers of student-centred, future-focused learning. These include collaboration, discussion, feedback and reflection, guided, explicit, demonstration, experiential and independent learning (NSW Government Department of Education 2016). Each mode requires students and teachers to be interacting differently with the learning space and each other and this has implications for both space design as well as the curriculum, pedagogy and lesson planning.

In Australia significant financial investment into public school learning spaces that aim to 'engage students in ways that reflect 21st century learning', was announced in 2015 (NSW Government Department of Education 2015), and in 2017 the NSW Department of Education committed $6 billion towards public school infrastructure over the next 4 years (NSW Government Department of Education 2017). This suggests broad policy support for the move away from traditional classrooms towards flexible learning spaces, though schools are left with considerable autonomy around what this means for them and how they go about implementing these changes. Over the past few years increasing numbers of schools in the State have embarked on the journey of transforming their classrooms. Research into the impact of these new generation learning environments on academic outcomes and student wellbeing is gaining momentum (Blackmore et al. 2012) and findings suggest that flexible spaces can support and facilitate the use of student-centred pedagogy and enhance student autonomy and wellbeing (Byers et al. 2018; Kariippanon et al. 2018). However there is limited critical analysis of (1) why and how schools are embracing and embedding these changes, (2) the implications this has for how effective flexible learning spaces will be in supporting a sustainable approach to teaching and learning, and (3) what this means for how Departments of Education and schools connect in the process of creating and supporting change (Blackmore et al. 2012; Mulcahy et al. 2015).

Historically educational reform has been fraught with failure (Fullan and Pomfret 1977), resulting in changes being applied at the surface level but rarely altering the practice of teaching in a sustainable way (Fullan 2015). Elmore (2016) notes that there are macro and micro influences of the context in which any reform takes place, suggesting therefore that the idea of achieving reform at 'scale' is based on a superficial and wrong understanding of what constitutes sustainable educational change. It is understood that neither solely top–down policy-led directives, nor bottom–up ad-hoc strategies are effective in bringing about lasting, impactful change; but rather a combination of both is required (Fullan 1994; Organisation for Economic Co-operation and Development 2017). This appears to apply equally to reform of school learning environments, and the notion that a participatory and 'generative design' process driven by educators and students is required, arises frequently in the literature (Higgins et al. 2005; Temple and Fillippakou 2007).

Historically the typical classroom dimension of 60 m^2 was required to accommodate about 30 students. This left little room for students to move or alternative furniture layouts other than front facing (Fisher 2016). The space thereby dictated

to a large degree how educators could teach and reinforced the teacher-led approach. However, until recently there has been a distinct lack of recognition of the power and influence of space on school organisational structures and learning (Fisher 2002). There is now a limited but growing field using evidence-based design to guide the development of new generation learning environments (Fisher 2016). Interestingly the literature on the relationship between pedagogy and the indoor built environment does not stem from educational research, but is largely found in built environment and environmental psychology journals (Ucci et al. 2015).

Whilst a review of the literature on the design of learning spaces found that sound architectural principles and contemporary educational philosophies are being taken into account, there is often insufficient recognition of the significance of the individual school context (Blackmore et al. 2012). The danger exists that schools may 'jump on the bandwagon' of opening up and fitting out classrooms with modern furniture, without doing the necessary work of examining at their own local realities and adapting their teaching approaches to ones suited to flexible learning spaces.

The literature suggests a general assumption that structural changes to the built classroom environment will translate into changes in teaching and learning, a notion that is not supported by empirical evidence (Blackmore et al. 2012; Mulcahy et al. 2015). The consequences of placing teachers and students into flexible learning spaces where the furniture has changed but the teaching approach remains teacher-led and didactic, are unknown. However this may not be dissimilar to the trend of 1:1 computers in classrooms, which, without holistically considering the complexity of the interaction between all agents and elements at play, can result in unintended negative consequences for student learning such as introducing distraction and psychological as well as physical strains (Islam and Grönlund 2016).

In addition research has established a lack of 'environmental competence' among teachers (Lackney 2008) which impedes their ability to capitalize on the affordances of the physical learning environment for pedagogical benefit and ultimately improved academic outcomes. This further emphasises the need for professional development and ongoing support for teachers to ensure flexible learning spaces are used with maximum effect, resulting in the sought after benefits that will ensure changes are sustained in the long-term.

From the plethora of attempts at educational change spanning the latter half of the twentieth century in schools across the globe, valuable lessons have been learned about the complexities of the change process. Fullan (2015) states that the development of a shared meaning among those enacting and affected by the change, coupled with an understanding of how change is experienced, lie at the heart of successful educational reform. Fullan (2015) further emphasises that if mastery of the change process is not prioritised, change initiatives will not result in the sustained success that is being sought. The challenge thus lies in finding the balance between a 'one-size-fits all' approach, and isolated, localised action that fails to capitalise on the evidence on what is effective and replicable in terms of processes.

To contextualize the study discussed in this paper, the change processes being examined here occurred in a small number of Government primary and secondary schools in NSW Australia. Prior to any policy directives or funding announcements, these schools had begun to embarked on individual journeys of adapting their

pedagogical approaches and the built environment of their classrooms, transforming them into 'flexible learning spaces' (NSW Government Department of Education 2015). This study sought to document *why* and *how* these early adopter schools initiated and managed this change process within their respective school communities and under what conditions continuous improvements occurred.

Theoretical lens

The use of Complexity theory as a lens through which to gain deeper insight into how the educational change process unfolds in a given ecology is still nascent (Lemke and Sabelli 2008). A central concept within this theoretical paradigm is the 'complex adaptive system' which can be defined as a coherent whole, an autonomous entity comprised of parts that are relatively independent of one another (Luttenberg et al. 2017). Mason's (2008) seminal work on the implications of complexity theory for educational change describes schools as such 'complex adaptive systems', comprised of agents and elements. Agents refer to the people within the educational environment that have influence over how change processes unfold, whereas elements constitute the conditions under which the agents act. In the context of this study, agents include the Department of Education, school leadership teams, teachers, students, the broader community and external consultants such as suppliers of school furniture. The elements that create the conditions include, but are not limited to global discourse around 21st century schooling, the decentralised nature of decision making at the local level, school ethos, professional development, the pedagogical approach, and the physical classroom environment.

Complexity thinking emphasizes the importance of the dynamics of the interactions among the agents and elements within the educational system and how out of these interactions, new phenomena and behaviours emerge that may not have been 'contained in the essence of the constituent elements' (Mason 2008, p 35). Complexity theory thus recognises the need for impetus at both the human agency as well as structural level in order to effect change. The ways and degrees to which this occurs are unique to the specific context, but always require significant effort at every possible level. The complexity paradigm does not seek to predict outcomes of particular processes, but rather aims to enable comprehension and explanation of what is occurring (Mason 2008).

The results from this study are discussed in light of three themes that align with complexity constructs (see Table 1), which seek to explain what is transpiring. These are *'creating inertial momentum and emergence'*, *'interactions among agents and information flow'* and *'feedback loops and lock-in'* (Mason 2008). The pedagogical and built environment changes taking place in schools are mutually constituted and influenced by factors at multiple levels of the educational system. To enable understanding of how complexity constructs are operationalized it is helpful to further break down the broader educational ecology into the macro, exo, meso and micro levels described by Bronfenbrenner (1993) in his ecological model. Figure 4 depicts an ecological model of factors of influence on educational change, adapted from Toh (2016). This facilitates examination of where and how the constructs are at play within the different levels of the complex adaptive system.

Table 1 Themes, sub-themes and descriptions

Theme	Sub-theme	Description	Research question
1. Creating inertial momentum & emergence	School ethos, 21st century needs, pedagogical approaches	Pre-disposing conditions that led to the transformation of classrooms into flexible learning spaces	Why are schools adapting their classrooms to create flexible learning spaces?
2. Interactions among agents & information flow	Consultation, participation and ownership, professional learning	The different types of dynamic interactions between stakeholders	How did the process of transforming classrooms into flexible learning spaces unfold?
3. Feedback loops & lock-in	Phases of change, external support, transitioning, broader implementation	Enablers and barriers affecting the development and use of flexible learning spaces	What are the implications for how change can be supported more broadly?

Methods

This study used an interpretive qualitative case-study approach to examine school leadership teams', teachers' and students' experiences and perceptions of designing and implementing flexible learning spaces in four New South Wales Government primary and four secondary schools that had independently made changes to their learning environments.

Participants

Since this study was conducted before funding and resourcing for flexible learning spaces was made available, only a small number of schools had embarked on making changes to their learning environments. Purposive sampling (Patton 2002) was therefore used, with the NSW Department of Education identifying 12 schools that had transformed their pedagogical and built learning environments. These schools were considered early adopters of future-focused learning and were deemed appropriate case study candidates with whom to explore the research questions. The schools were approached to participate in the study via email, and four primary and four secondary schools in metropolitan Sydney and the Illawarra region of NSW Australia agreed to participate.

The three participant group categories (school leadership, teachers and students) were chosen in collaboration with the NSW Department of Education, who considered all three groups essential stakeholders with a valid voice. The groups were seen as having a role to play in implementing flexible learning spaces, and as being directly affected by changes to the pedagogical and built learning environment. Decisions on which specific school leadership members, teachers and students to include in the interviews and focus groups were made locally by each of the eight participating schools.

Eight interviews were held with school leadership teams. The 12 participants (5 primary and 7 secondary) were either school principals, deputy-principals or head teachers. Interviews took between 1 and 1.5 h. Teachers participated in one of eight focus groups, which took approximately 45 min and involved up to five teachers. Thirty five teachers participated (18 primary and 17 secondary), ranging in experience from early-career (0–3 years) to highly experienced (20+ years). Teachers represented primary school classes from Kindergarten to Year 6, and all key learning areas of the secondary school curricula. There were sixteen student focus groups lasting approximately 35 min each with 5–6 participants. The primary school student sample contained 45 students (42% female) from Years 5–6 (aged 9–11 years). The secondary school student sample comprised 40 students (53% female) from Years 7–11 (aged 11–17 years). The eight participating schools represented a broad range of socio-economic and cultural demographics with students belonging to over 20 different cultural backgrounds.

Principals from some participating schools suggested the importance of interviewing three external independent consultants who had provided advice to assist in

the adaptation of physical spaces and incorporation of technology into the curriculum. Three independent consultants agreed to participate; two from interior design and school furniture firms and one educational advisor. These independent consultants each participated in a telephone interview that took approximately 30 min.

Instruments

Standardised open-ended interviews were held with school leaders, to discuss the broader reasons and processes used to facilitate changes to the built classroom environment and the pedagogical approaches employed by teaching staff. This method allowed a comparison of answers between schools, while still capturing unique thoughts and insights (Patton 2002). Three interviews were conducted with the independent consultants, focusing on the services they provided to schools and the processes used during their engagement. Focus group interviews were used for the teacher and student samples to encourage the generation of data on a given topic resulting from the interaction between group participants, with participants' views being refined in light of the contributions of others (Ritchie et al. 2014).

Questions for both the leadership team interviews and teacher and student focus groups were developed on a collaborative basis, taking into consideration the identified needs of the NSW Department of Education who had contracted the evaluation, and the research teams' understanding of the context and knowledge gaps identified in the literature. Some questions were asked of all participant groups to facilitate source triangulation and ensure the collection of robust and comprehensive data. Questions for the independent consultant interviews centred on the specific support they had provided to the schools.

Procedure

Ethics approval was obtained from the University of Wollongong's Human Ethics Research Committee (HE16/021) and the NSW State Education Research Applications Process (SERAP). Participants were provided information detailing the purpose and nature of the evaluation, confidentiality and an explanation of how the data would be used. Written consent was obtained for all participants.

Schools selected participants based on the following criteria. School leadership teams were required to have been centrally involved in leading the transition to flexible learning spaces within their school. Teachers were required to regularly teach in flexible spaces. The primary student sample was selected from Years 4–6 (ages 9–11) to avoid challenges regarding reliability and distractibility (Donaldson 1978). Secondary students represented a range of year levels from 7 to 11 (ages 11–17). Additional criteria included ensuring gender balance and a range of students across the learning ability spectrum.

Interview and focus group questions served to initiate discussion to provide an understanding of how learning spaces were transformed in the school, the processes involved and support received. Probes were used throughout to encourage further elaboration of participant responses. All interviews and focus groups were audio

recorded and transcribed verbatim. The transcripts were then imported into NVivo 10.0 software for conding.

Data analysis

As suggested by Patton (2002), data analysis began during fieldwork. Patterns were discussed in a peer-debriefing process (Lincoln and Guba 1985) and as insights deepened, interpretations emerged. Focus groups and interviews proceeded until data saturation was reached.

Content analysis was conducted in NVivo based on the protocol described by (Braun and Clarke 2006). To facilitate the use of complexity theory as a lens through which to interpret the results, coding of the data was guided by pre-defined complexity constructs considered central to a complex adaptive system. These are *'creating inertial momentum and emergence', 'interactions among agents and information flow'* and *'feedback loops and lock-in'* (see Table 1). Upon review and comparison of the coded data, a deductive process was used to look for concepts derived from: discussions with the Department of Education, an understanding of the research literature, and from field-based analytical insights. Based on this, sub-themes were developed across the three data sets (leadership teams, teachers, students). To heighten the 'trustworthiness' of our interpretations, the sub-themes were discussed and refined by the research team.

Results

In all eight schools several rooms had been transformed into flexible learning spaces, categorized by changes to the built environment, teaching practices, technology and resources. Physical modifications entailed the removal of rows of desks and chairs, and the inclusion of various furniture items that could be configured to facilitate a range of learning experiences, particularly group work and collaboration. There was an emphasis on freeing-up space, with the inclusion of furniture such as couches, ottomans, beanbags, standing desks and writable tables and walls, to replace the standard desk and chair for each student (see Figs. 1, 2). In some schools the transformation involved structural changes to classrooms, with walls removed to facilitate the creation of open space and smaller break-out areas for quiet work.

Many spaces had incorporated technology including electronic tablets and laptops with Internet access, interactive touch screen TVs, smart-boards and a range of educational software such as google classroom to enhance collaboration, creativity and feedback. Whilst technology was also used in traditional classrooms, many flexible spaces were designed to facilitate the use of technology through ensuring Wi-Fi connectivity and strategic placement of additional power points and USB ports to enable charging and connection of devices.

Discussions with school leadership teams, teachers and to some extent students, revealed an organic approach to educational change. The modifications to

Fig. 1 A primary school flexible learning space

Fig. 2 A secondary school flexible learning space

the schools were described as evolving from: (1) a deep sense of commitment to meeting the changing needs of students, (2) investigation of and reflection on the local realities of teaching practices and the learning experiences occurring in their classrooms, and, (3) engagement with research evidence, personal learning networks, professional development and support.

Key complexity constructs were used to categorise the findings into three themes (see Table 1). *Theme one* outlines the reasons why schools adapted the pedagogical and physical elements of their learning spaces, which at the time, was a shift away from common practice and in the absence of a policy directive from the

NSW Department of Education. The *second theme* highlights the interactions that occurred between a range of stakeholders during the design and transformation of classrooms and the effect this had on the sense of ownership and acceptability of these spaces. The *third theme* describes the scaffolding used by schools to implement their new classrooms to maximize the potential impact on teaching, learning and wellbeing and achieve sustainability in terms of changes to teaching practice.

Theme 1: Creating inertial momentum and emergence

All schools, with the exception of one, transformed their schools without receiving additional funds. Drawing on existing resources and budgets, all eight participating schools had initiated significant changes to both the classroom built environment and their teaching practices prior to the NSW Department of Education's commitment to fund and support a state-wide transformation of traditional classrooms into flexible learning spaces. It is worth noting that the modest budgets of some schools may have limited the extent of the changes they wished to make.

School ethos

At the organisational level all participating schools demonstrated an ethos characterised by a willingness to reflect and consult on the realities of didactic learning environments, having come to recognise that these no longer met their teaching and learning needs. Principals discussed a commitment to reinventing their 'business as usual' approach and were acutely aware of the need for this initiative to ultimately become a 'whole of school' approach to be sustainable and achieve the intended outcomes and benefits to overall student learning across subject areas. Schools exhibited a culture of learning, preparedness to try, fail and adapt, earnestly striving to better meet student needs.

Teachers also highlighted the value of trust and belief in one another and the importance of leadership and collegial willingness to support innovative ideas and try different approaches. A united vision for the school, its teaching and learning needs, and a shared understanding of what this could entail, despite not being certain of how to achieve it, was further highlighted as being essential for success.

> … there is a genuine culture of trust and belief in people and therefore everybody does it differently and that's okay and people feed off each other inspired by what they see from each other and that leads to, well it eventually leads to greatness because you're joining heads and brains together and what somebody starts with is not necessarily what they'll end with because they work together. - Primary School Teacher

Twenty-first century needs

School leadership teams and teachers found that current practices were increasingly falling short of keeping students focused on learning. Schools experienced students becoming disengaged from the educational content and processes and the schools felt compelled to address why this was occurring. School leadership teams and teachers discussed turning to research evidence to deepen their understanding of new ways of engaging students, coupling this with an evaluation of their own practices to establish what changes could be made.

Participating schools joined the groundswell of momentum taking place, both at the research and practice level, locally and globally, and were guided by evidence-based findings as well as by the context within their own classrooms, adapting to the new possibilities being created by elements such as the increased incorporation of technology.

> … we'll keep pushing the envelope because the more you experiment and try new things, the more questions will derive from that and then you just have to find the answer and I think it's a natural process… re-educating ourselves and making sure that we're kept on our toes as teachers and utilizing the stuff that these kids are learning from and bringing that into the classroom is essential for those twenty-first century learners - Secondary School Teacher

Teachers felt a particular responsibility to prepare students for tertiary education settings and/or the workplaces of a complex and rapidly changing world. Principals and teachers reported a sense of responsibility to move beyond the delivery of content and standardised assessment, rather wanting to assist students to develop a range of higher-order skills such as critical thinking, problem solving, being effective communicators and having the ability to collaborate.

> It was looking at, how can we remain relevant and how can we teach those twenty-first century learning skills to our children. How can we engage kids and prepare them for a jobs world that is constantly changing. So creating those relevant, creative, collaborative, problem solving citizens. - Primary School Principal
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> We know that they're going to inhabit a future very different that requires them to be positioned differently, to think critically and creatively, they need to be able to use technology efficiently. - Secondary School Principal

Teachers also considered the physical environments of the future. It was envisaged that students would be going into workplace settings where they would work collaboratively and there was a belief that schools should mimic these environments. Teachers and leadership teams also highlighted how students do not necessarily sit at a desk in their home environment to do their homework, often lying on their bed or couch, sitting on the floor or standing at the kitchen bench. Again schools felt it useful to replicate these options in the classrooms. Further, because students spent a considerable proportion of their waking hours at school, it was believed that there was value in creating more comfortable and flexible learning environments.

Pedagogical approaches

School leaders and teachers believed that from a pedagogical perspective a move away from didactic teaching to a more student-centred approach to learning would facilitate and foster collaboration, peer teaching and self-regulation. The role of students as active participants in their learning was highlighted and project-based learning was seen as an alternative means of curricular delivery that could facilitate this co-construction of the learning process for students. It was envisaged that this in turn would lead to improved student engagement, motivation and ultimately improved learning outcomes.

> … for learning to be deeply engaging, students need the opportunity to co-create their learning with each other, their teachers and other adults; it needs to be personalised and passion led; it needs to be connected to the world beyond school, both through technology, but also about bringing experts from beyond the school gates in… and then it needs to be integrated across subjects and possibly groups. Traditional learning spaces don't allow for most of those things to happen - Secondary School Principal

Teachers discussed the crossover in the syllabuses of different faculties and how project-based learning employed in flexible learning spaces provided opportunities for teaching across several key learning areas simultaneously.

> There was so many literacy tasks that were happening in history and geography … I could do things empathy tasks for history or geography, reflect on being in a natural disaster… or in with geography you could get TAS (technology and Applied Studies) involved to design and build a model. - Secondary School Teacher

Student-centred learning was defined by a move away from "chalk and talk" with teachers employing differentiated instruction and incorporating technology as a means for offering students an enhanced personalised learning experience, by enabling follow-up and deeper investigation into areas of personal interest beyond what is delivered to the whole class. Further, teachers sought to foster students' self-regulation and reflected on how the learning spaces mediated this change.

> We explicitly teach part of it, and then the space supports them - through trial and error - to develop those skills to self-regulate. We need to give them the opportunity to experience those successes and failures so that they learn from that and are able to manage their learning. - Secondary School Teacher
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> Pedagogies around, for instance, personalised learning, project based learning; and those lessons required students to be able to get up and move around; it required students to make choices and be self-regulatory in terms of whether they needed to work by themselves quietly or whether they needed to work in a group, or whether they needed to be working with a much larger group or a whole class. - Secondary School Head Teacher

Changes to classroom layouts and furniture were seen as an inevitable consequence of moving towards future-focused learning. However for some schools it seemed like an 'after-thought' born out of necessity to enable the pedagogical shift. Staff commented that the layout and type of furniture within spaces facilitated these new pedagogies and that on the flip side a flexible space may leave teachers with no choice but to adapt their teaching practices.

> The space helps us change the learning, and then the learning feeds into how we need to change the space. So it kind of becomes an iterative approach - Secondary School Principal
> The space has also helped encourage a bit of change as well… when you know that you're going to be in the flexible space you have to think differently. You can't just go, "I'm just going to go in and write some stuff on the board, get them to answer questions, keep them quiet, get them out," because you actually literally don't have 30 desks for them to sit at and stare at the board… so you are not only encouraged but in some instances you're sort of forced to change it (pedagogy) and push it to the students to be really driving the lessons. - Secondary School Teacher

Theme 2: Interactions among agents and information flow

Consulting with and involving teaching staff, students and the community in the development and transformation of learning spaces, was considered the most vital element in creating a sense of ownership to ensure the ultimate success of these spaces. While in all schools the initiative was orchestrated by the principals, in primary schools it was always championed by a classroom teacher and in secondary schools a faculty head teacher, who over time, were able to build momentum for the initiative and harness the enthusiasm of other teaching staff. These 'coalitions of the willing' acted as key leaders of change, with the principal's role being to provide the required resources and to facilitate the transformations. Principals emphasised that staff were never required to implement flexible learning spaces; rather teachers were given the choice, and supported to act when ready.

Consultation

Across all participating schools it was believed that a 'one-size-fits-all' approach would not produce the intended outcomes. It was seen as vital to take into consideration the unique needs of schools, as dictated by the student cohort, as well as variations between faculties within a school, to ensure the right decisions regarding furniture and resources. There was a sense that teachers' voices were heard around both pedagogical approaches as well as the transformation of spaces. Consultation with teachers and among teachers was described as vital to the success of flexible learning spaces, given their significant vested interest. In addition, the insightful contributions from teachers facilitated by their intimate knowledge of the teaching and learning needs within their classes were valued by school leadership teams.

> It's a blank canvas, I'm really interested to hear what your (teachers) ideas are and then what's your rationale?- Secondary School Principal

Student consultation generally occurred once decisions had been made to trial new approaches to teaching and transform learning spaces. Students were given the opportunity to participate in a variety of ways. In primary schools students were invited to share their ideas developing floor plans and models of what they envisaged the new future-focused learning spaces would look like (see Fig. 3). In secondary schools students participated in discussions around their classroom needs, were provided information to inform their thinking (e.g. about ergonomics), and were then involved in decision making processes.

> We held a design-to-learn meeting and asked the student body to come along… we thought we'd get 12–13 students, we got over 100. So they really wanted to be involved and we gained their input on a lot of things - we were absolutely amazed, we didn't expect that level of interest. - Secondary School Head Teacher
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> The architects were asking the kids what would they want and we just told them our ideas on what should be there and what shouldn't… I feel that the student's ideas are really good because it's pretty much their school. - Secondary School Student

Participation and ownership

The ways in which the leadership of participating schools sought the involvement of teaching staff and students reflected their inclusive ethos, which recognised the importance and value of different voices and perspectives. Involving teaching staff was particularly emphasised in schools where significant pedagogical changes were being made. In the majority of schools, teachers were centrally engaged from the beginning of the process and were often seen as champions of the initiative in their respective schools. Principals valued the role of key teachers who were instrumental in championing the changes for other teaching staff; rather than the changes being imposed on them from the school leadership level.

Fig. 3 A students model of a flexible learning space

> We've got a lot of change agents who aren't necessarily executive staff, who really believe and support in what we're doing. Because you can't really create this kind of change if you just have three people at the top who don't have a class of their own saying let's do this- Primary School Principal

Students spoke of the opportunities to participate in planning and design process and expressed valuing this.

> …the way our school is sort of centred, operates, it is very passionate about student voice… our principal, other executives along with a few students went over some designs for the classrooms… That opportunity was open to most students. So everyone's ideas sort of came together. Having a say and an opinion and contributing to the designs and the desks that the school would order, that was good. - Secondary School Student

Primary school students in particular expressed a sense of pride in their classrooms and were quick to express excitement and contentment due to their involvement in the decision making process related to elements of their classroom space. In secondary schools this sense of ownership and acceptance of the space was demonstrated through a marked decrease in vandalism of furniture items, which was noted by all schools and was sustained over time.

> They don't graffiti the tables. They don't put chewing gum on the tables. They don't draw on them like they used to - Secondary School Teacher

Secondary school students also believed that the investment schools made to their learning spaces showed that the school really valued and respected them and in turn this motivated the students to strive harder in their school work as a sign of their appreciation.

Professional learning

Professional learning for teachers was provided both formally and informally through training courses, conferences or peer observation of those teaching in flexible spaces. Teachers saw these professional development opportunities as essential, and staff and students both agreed that the success of the flexible spaces was largely dependent on the teacher's skills to work effectively in the space with their students. It was deemed vital that teachers embraced the changes in pedagogical approaches and were willing, competent and confident to utilise these in parallel with modifying the physical environment of classrooms.

Professional development was typically accessed both externally and internally. Formal external professional development included visits to schools that had developed flexible learning spaces and were applying a student-centred approach to teaching and learning. Some teachers attended conferences or training workshops, which deepened their understanding, and this knowledge was then shared with colleagues. Staff also accessed learning networks, particularly online. Exchanging ideas and experiences with like-minded professionals was frequently raised by both school

principals and teachers as being informative and invaluable, contributing richly to their evolving understanding and practice.

> Social media has played a big part in our connections… started the Twitter chat and we were able to connect with a lot of people, not just locally, and have those discussions about the pedagogy and learning spaces because I think there's a lot of ideas. People would post photos and things of what they do and it was very useful… - Primary School Teacher

One of the key forms of professional learning however was generated at the grassroots level, within the classrooms of enthusiastic teachers who shared their practical learnings with others in their schools. Observing classes in action was actively encouraged and significantly helped to break down barriers to change. Schools varied in how they approached observational learning. In some schools it was flexible and informal, in others there was a concerted effort involving the school's Learning and Support staff who facilitated cycles of planning, action and reflection.

> Then we invested in developing a learning hub, which was really a breeding ground for teachers - a training ground - to build their capacity to use flexible spaces; as some people felt very nervous about it - Secondary School Principal

Theme 3: Feedback loops and lock-in

In each participating school some challenges were experienced as schools transitioned from traditional classrooms to flexible learning spaces. In some instances this was due to inappropriate furniture selection, ineffective classroom layout or the introduction of a new teaching strategy that had not been received as intended. Schools approached these with an openness to adapt and collaborate with staff and students to solve issues, again reflecting a school ethos of supportive collaboration and readiness to learn.

Phases of change

All schools used a phased approach to implement the two aspects of flexible learning spaces—the change to pedagogy and the transformation of the built environment. In practice this meant working with the change agents who were already convinced of the need for change and beginning with modifications to one or two classrooms as a means of trialling new ways of teaching and different items of furniture. This approach served two purposes.

First, it provided an opportunity for teachers and students to gain some experience using the modified classrooms, reflect, evaluate and make adjustments. Second, it gave staff who were sceptical of the value of the initiative an opportunity to see the spaces in action and re-evaluate any potential resistance they harboured. Observation and subsequent discussions allowed them to learn from their colleagues' experiences. This 'peer to peer' support was seen as more effective in promoting widespread acceptance of the initiative, than if it had

been implemented as a top-down approach from the outset. As a result staff were able to "buy in" at the level they wanted to and gradually become increasingly involved with the initiative.

> …it's creating that mindset within the teachers to view this as okay, it's change and change is scary and it's challenging and it's evolving. It's about flexibility and that's what we need to be in the 21st century anyway - Secondary School Teacher

In the primary schools the majority of classes were transformed into flexible spaces at the year level, or plans were in place for their transformation and the initiative was seen as a whole-of school approach. In secondary schools it was more common for a limited number of spaces to be transformed, with most still functioning as traditional classrooms. These changes were largely made at the faculty level, as the needs between faculties varied considerably and faculties tended to operate somewhat separately. There was however recognition of the opportunities flexible learning spaces provided to merge key learning areas and to incorporate team teaching across different subjects with the potential for multiple learning outcomes as a result of this collaborative approach.

External support

Schools differed in their selection of furniture and space design. Several schools engaged external consultants with expertise in the design and fit-out of learning spaces. This decision was driven by the belief that guidance and support from 'experts' could only be beneficial and that furniture provided through these companies would be custom made for learning environments and therefore of superior quality and standard. These consultants conducted interactive workshops with teachers and students to assist them to reflect on their requirements and make appropriate choices that would facilitate their teaching and learning needs.

> …we conduct workshops with clients to look how they create their own learning environment based on their own pedagogy, culture and objectives. Then once we have a true understanding of what they want, we can start to marry our ideas and thoughts into that. In that regard we're a little bit different to many of the other suppliers, who would basically design a learning environment for the school. We co-create that environment with them- External Consultant from a school furniture supplier

Schools that did not seek external advice or preferred to source their furniture from generic stores did so largely due to budget constraints, but also because they found it helpful to trial different pieces of affordable furniture rather than committing to a set selection at a higher cost from the outset. Further, cheaper furniture could be changed more frequently, allowing for greater flexibility.

Transitioning

It was acknowledged by all participant groups that students also required time and support to transition into flexible learning spaces. Because of the shift in pedagogy, expectations on students had changed. There was an increased need for students to collaborate and engage in greater self-directed learning, and these were skills students needed to learn to master.

> Well, the students have to learn how to learn in these spaces just as much as we have to learn how to teach them - Secondary School Teacher
> The transition period will last as long as there are students with a memory of the traditional classroom. - Secondary School Teacher

Broader implementation

In the broader context, school leadership teams and teachers were explicit in stating that physical changes to the classrooms needed coinciding support for pedagogical change. They believed if schools were encouraged to 'jump on the bandwagon' of purchasing modern furniture; painting their classrooms bright colours, without pedagogical support, then there would be minimal positive outcomes for teaching and learning and any initial encouraging impact due to the novelty of the changes, would not be sustained. Principals spoke of other initiatives that were driven from the top down, where opportunities for real lasting impact had been missed, and cautioned against a rushed implementation of the initiative that did not prioritise changes to teaching above cosmetic transformations to the built environment. The value of learning from schools, who had already embraced both changes to teaching approaches as well as physical classroom transformations, was frequently emphasised.

School leadership teams voiced their concerns about how a state-wide 'implementation' of flexible learning spaces would be managed, and the danger of using a 'cookie-cutter' method, that lacked the flexibility to be adaptive to local realities.

> The spaces we've set up in the common room and the library are kind of one-size-fits-all, but when we put the expression of interest out to the faculties, they have very different needs. The learning space that Technology and Applied Studies has developed is very different to what the Performing Arts faculty is developing, which is different to what English wanted. That local choice at a school level is really critical, but actually within a school, local choice for teachers and faculties is also really critical.- Secondary School Principal

Through the processes of identifying, working through challenges and finding creating solutions, each school made considerable headway in bringing on board teachers initially reluctant about the initiative and were able to begin to establish new norms around learning environment design and teaching practices.

Discussion

As can be seen from the results, the educational change processes that unfolded within the participating schools are characteristic of what occurs in a 'complex adaptive system'. In this discussion the key constructs of complexity theory are examined across the factors of influence on educational change, at the macro, exo, meso and micro levels of Bronfenbrenner's (1993) ecological model (see Fig. 4). The discussion aims to illustrate how the agents and elements within the complex adaptive system are at play at multiple levels, often simultaneously, highlighting that influences are not unidirectional and causation is difficult to determine.

From a macro-level perspective, the dominant global educational system is frequently referred to as a 'century old, industrial-era, factory model', designed to maximise efficiency and minimise cost. This system of education, which has persisted largely unchanged since the 1800s (Cuban 2013) remains characterised by traditional classroom layouts, typified by rows of desks and chairs and teacher-led instruction. The complexity theory construct of *lock-in* explains how the positive feedback and self-reinforcement that initially stemmed from this model of education when it was being embedded, ultimately resulted in an autocatalytic, self-sustaining phenomenon, hence becoming the normative model of education. Over the past decades there has been increasing recognition that the status quo of the education system, and the way in which teaching and learning operates at the classroom level, is no longer as effective in achieving the necessary outcomes, because the goal posts of what the outcomes of schooling need to be, have changed and continue to evolve in our technology-driven global economy. However, to bring about educational change in a system that is as *locked-in*, or as deeply entrenched in its modus operendi as our educational system, requires significant effort and dynamic interaction between the multiple agents, as well as adaptation of elements within the system to create the *inertial momentum* that can ultimately allow for new phenomena and behaviours to emerge.

Remaining at the macro-level, the findings of the present study highlight that certain elements such as the increasing disengagement of students collectively, the global trend towards meeting twenty-first century student needs, consumer (parents)

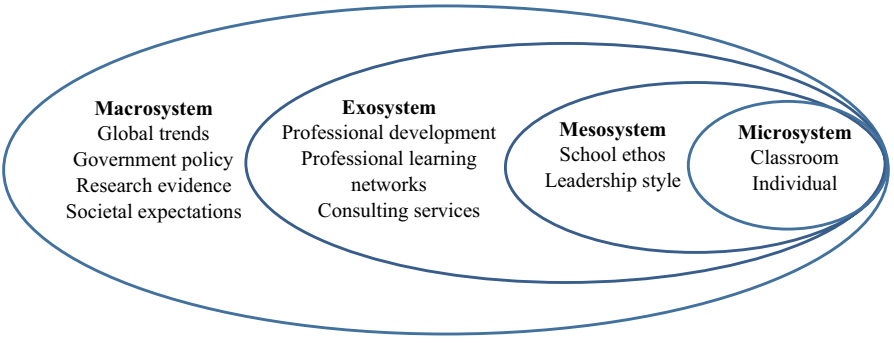

Fig. 4 Ecological model of factors of influence on educational change

and workforce demands for school graduates with transferable higher-order skills and evidence supporting student-centred learning; converged to set the stage upon which the agents within the system could interact, reflect and initiate this much needed *momentum* in a new direction.

While in Australia neither changes to the built classroom environment nor pedagogical reform are being mandated at a Departmental level, the significant financial investment being made by the Government, coupled with the fact that most new builds now heavily incorporate key features of the flexible learning space; suggest the direction policy makers are heading. To replace the successful *locked-in* traditional classroom and mode of teaching, with flexible learning spaces and a more student-centred approach, significant financial support for schools to bring about infrastructure changes and resources such as furniture and technology will certainly be required.

At the exo-system level, a group of actors central to the *emergence* of this paradigm shift in how learning environments can meet the learning needs of students, are architects and designers engaged in the research and development of learning spaces. Significant work is being undertaken to align pedagogy and learning environments, resulting in a rich body of work guided by diverse theoretical frameworks and methodologies (Fisher 2016). Design thinking enables a collaborative, user-centred process, where learning spaces are co-created together with end users, rather than delivered by facilities management. This results in spatial differentiation, underpinned by best-practice design concepts aligned with teaching and learning needs. The recent growth in m Multidisciplinary forums such as the Learning Environments Applied Research Network (LEaRN) bring together academia and industry to improve the design and use of learning environments (LEaRN 2019). The role of this and similar networks play in building a solid evidence-base to guide the transformation and evaluation of learning spaces is of critical importance.

However, as discussed by Mason (2008), with the *emergence* of new phenomenon comes the opportunity for those supplying goods and services to develop and even exploit niche markets within the ecosystem. This can be seen in the increasing number of classroom design and layout services and furniture suppliers, who consult with schools and assist them in the development and fit-out of their flexible learning spaces. Whilst the quality of these services is not under scrutiny here, there is a risk that these specialised service providers may encourage schools to circumvent the more organic process of exploring within their own context and allowing the changes to the built environment to occur in response to pedagogical adaptations, instead letting the exercise become somewhat of a 'cookie-cutter' approach, where pre-defined furniture and typologies are imposed on existing infrastructure. This has implications for how Ministries of Education that are increasingly putting significant financial support behind these initiatives, set criteria for how funds are distributed and used by the schools. Again this becomes a balancing act between providing sufficient guidance and professional development opportunities, ensuring the dynamic interactions between agents are fostered, and yet still allowing for local control and autonomy.

Remaining at level of the exo-system, we can see equally relevant *feedback loops* are at play. Mason (2008, p. 42) states that "positive feedbacks shaped towards a

particular outcome need to be created through conscious interventions, so that new patterns are established". Providing teachers with formal, accredited professional development opportunities, on a range of topics that can enhance their understanding and skills in the design and creation of flexible learning spaces, student-centred pedagogical approaches, and environmental competencies, is a conscious intervention that can contribute significantly towards creating *positive feedback loops*. As teachers apply their learning and share their experiences with their colleagues and broader professional learning communities, their rich experiences and increasing knowledge sheds light upon challenges and can create a further *feedback loops* that influences individual practice. Without being prescriptive however, this professional learning needs to provide teachers with knowledge and skills, but also allow them to retain the autonomy to adapt to the changing environment. Thus making a contribution to creating conditions in which educational change can take place (Toh 2016).

As the findings show, teachers valued encouragement and support from engaging with their peers in the journey of transforming their classroom and teaching practices, both within schools and among colleagues from other schools. Professional learning communities (PLCs) are increasingly recognised in the literature for their effectiveness in promoting teacher's learning (Philpott and Oates 2017) and their value in the broader context of teacher professional development and ultimately student outcomes (Schaap and de Bruijn 2018). Characteristic features of PLCs include shared values and vision, collective responsibility, reflective professional inquiry, collaboration and promotion of group as well as individual learning (Stoll et al. 2006). The role of teacher reflexivity whilst 'doing' has also gained increasing recognition, particularly in the action research space (Luttenberg et al. 2017). The continual process of action, reflection and consultation that teachers in particular were engaged in is key to achieving desired outcomes within the complex adaptive system. Capitalising on the affordances of social media, these informal networks of teachers often enabled collective learning to reach beyond the individual school level, ensuring that the learning could be shared and applied more broadly at a national and global level.

At the meso-level, the schools' ethos was characterised by a leadership style that strove to (1) cultivate a shared meaning and collective understanding of the purpose of embarking on this initiative, (2) a sincere belief in the capability of teachers to explore their role and determine their own readiness to participate, (3) the creation of conditions to allow the changes to happen (e.g., time, funding, resources) and (4) the freedom to learn through trial and error. Complexity theory tells us that with sustained intervention at multiple levels, new phenomena will emerge from the interactions between elements and agents (Mason 2008). The schools' ethos of prioritising consultation, participation and allowing ownership of what occurs in individual classrooms thus created the conditions to influence change in the desired direction. Whilst complexity theory does not predict outcomes as a whole, smaller changes at all levels, underpinned by and evidence base drawn from educational research, can collectively have the potential to impact on the *inertial momentum* and drive changes across the complex system more broadly.

How flexible learning spaces *emerged*, resulted in change processes that were somewhat unique to each school's individual context. This had further flow on as evidenced

by the divergence of outcomes, with schools varying in how successful they perceived their spaces to be (Kariippanon et al. 2018). Changes in perceived success depended largely on the degree of adaptation made to the pedagogical approach, and teachers' environmental competency to work effectively in the spaces. Whilst it was acknowledged that formal professional development was helpful and necessary, the willingness of teachers to participate in reflexive practices, was evident in those schools that demonstrated greater congruence between the views of the three participant groups and reported a higher level of perceived success of their spaces. In the schools where pedagogical reform mediated the transformation of learning spaces there was a notable difference in the depth of conceptualisation behind the need for pedagogical change. Further, these schools engaged in and valued an iterative process of continuous quality improvement be this through trial and error, cycles of planning, acting and reflection, or through observational learning, and articulated creating *feedback loops* that resulted in adaption of practice and learning spaces.

At the micro-level it is the teachers and students within their classrooms that displayed the greatest reflexivity and adaptation. The notion that components within complex adaptive systems are co-adaptive (Luttenberg et al. 2017) is highlighted by the interdependence between the pedagogical approach and the built classroom environment, which were described as going 'hand-in-hand'. In each school it was largely forward thinking principals and concerned, committed teachers who began to challenge their lived experiences of teaching in an age old prescribed built environment. Their willingness to go out of their comfort zones, experiment and adapt their pedagogical approaches and the furniture and layout of their classrooms, thereby bringing this initiative to life, on top of their already stretched workloads, is highly commendable. It is clear that the openness with which the various actors within each school approached the journey, their personal and collective reflexivity and flexibility to evolve and adapt throughout the process contributed towards the perceived success of these innovative learning environments, from a teaching, learning and student wellbeing perspective (Kariippanon et al. 2018).

A limitation of this paper is that the results are based solely on reported perceptions of why and how flexible learning spaces have been developed in schools. From a complexity perspective the interplay between learning spaces and teaching and learning is emergent and situational and classroom observations that give insight into how learning and teaching unfolds in the real context, would enrich the discussion. Whilst the perceived effects of flexible learning spaces on teaching and learning, as reported by the same group of participants, has been published (Kariippanon et al. 2018), ethnographic research that enables further in-depth exploration, particularly of how the *feedback loops*, reflexive practice, adaptations and eventual *lock-in* occurs, would add additional depth to our understanding.

Conclusion

The findings of this study illustrate how pedagogy-mediated changes to the built learning environment both shape and are shaped by a complex interplay between elements and agents within the educational ecology. The analysis of these findings

highlight implications for how Departments of Education engage with schools as they fund, guide and support the transformation of traditional classrooms into flexible learning spaces, both here in Australia and internationally. Examining how educational change processes occur through the constructs of complex adaptive systems brings to the forefront the need for openness, embracing uncertainty, reflexivity and being adaptive to individual school contexts, whilst supporting the organic unfolding of educational change processes at the local level. This creates somewhat of a paradox for Departments of Education that carry the weighty responsibility of allocating funds in an effective and equitable manner, whilst ensuring that educational and infrastructure standards are met. Developing systems that achieve consistency in terms of structure and outcome, are accountable and equitable, yet are simultaneously able to be flexible and adaptive to respond to local context as schools venture into unchartered waters, is the significant challenge that lies before Departments of Education. Historically educational change initiatives have failed too often. The present groundswell of action towards better meeting the needs of our school students through pedagogy and built environment reform is an incredible opportunity to prepare today's youth for their future. Overall it is encouraging to see the level of commitment to the process of educational change exhibited by the various agents within each school and the broader educational ecology. Further research is required to assist Departments of Education to rise to this challenge.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Blackmore, J., Bateman, D., Cloonan, A., Dixon, M., Loughlin, J., O'Mara, J., et al. (2012). *Innovative learning environments research study*. Melbourne: Department of Education and Early Childhood, Victoria/OECD. Retrieved November 12, 2018 from http://www.learningspaces.edu.au/docs/learningspaces-final-report.pdf.

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

Bronfenbrenner, U. (1993). Readings on the development of children. *Ecological models of human development* (pp. 37–43). New York: Freeman.

Byers, T., Imms, W., & Hartnell-Young, E. (2018). 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.

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

Cuban, L. (2013). Why so many structural changes in schools and so little reform in teaching practice? *Journal of Educational Administration, 51,* 109–125.

Donaldson, M. (1978). *Children's minds*. London: Fontana.

Elmore, R. F. (2016). "Getting to scale… "it seemed like a good idea at the time. *Journal of Educational Change, 17,* 529–537. https://doi.org/10.1007/s10833-016-9290-8.

Fisher, K. (2002). Schools as 'prisons of learning' or, as a 'pedagogy of architectural encounters': A manifesto for a critical psychological spatiality of learning (PhD Dissertation).

Fisher, K. (2016). *The translational design of schools: An evidence-based approach to aligning pedagogy and learning environments*. Rotterdam: Sense Publishing.

Fullan, M. G. (1994). Coordinating top-down and bottom-up strategies for educational reform. In R. J. Anson (Ed.), Reform perspectives on personalizing education (pp. 7–22). Washington: Office of educational research and improvement, Office of Research.

Fullan, M. (2015). *The new meaning of educational change* (5th ed.). New York: Teachers College Press.

Fullan, M., & Pomfret, A. (1977). Research on curriculum and instruction implementation. *Review of Educational Research, 47,* 335–397.

Higgins, S., Hall, E., Wall, K., Woolner, P., & McCaughey, C. (2005). The impact of school environments: A literature review. *Design Council*. https://doi.org/10.3102/00346543049004577.

Islam, S., & Grönlund, A. (2016). An international literature review of 1:1 computing in schools. *Journal of Educational Administration, 17,* 191–222. https://doi.org/10.1007/s10833-016-9271-y.

Kariippanon, K. E., Cliff, D. P., Lancaster, S. L., Okely, A. D., & Parrish, A. M. (2018). Perceived interplay between flexible learning spaces and teaching, learning and student wellbeing. *Learning Environments Research, 21,* 301–320. https://doi.org/10.1007/s10984-017-9254-9.

Kuhlthau, C. (2015). *Guided inquiry: Learning in the 21st century* (pp. 1–8). Center for International Scholarship in School Libraries (CISSL), Rutgers University, USA.

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

LEaRN (2019). Learning environments applied research network (LEaRN) [WWW Document]. https://research.unimelb.edu.au/learnetwork/home.

Lemke, J., & Sabelli, N. (2008). Complex systems and educational change: Towards a new research agenda. *Educational Philosophy and Theory, 40,* 1–33.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage.

Luttenberg, J., Meijer, P., & Oolbekkink-Marchand, H. (2017). Understanding the complexity of teacher reflection in action research. *Educational Action Research, 25,* 88–102. https://doi.org/10.1080/09650792.2015.1136230.

Mason, M. (2008). What is complexity theory and what are its implications for educational change? *Educational Philosophy and Theory, 40,* 35–49. https://doi.org/10.1111/j.1469-5812.2007.00413.x.

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

NSW Government Department of Education. (2015). First look at NSW classrooms of the future. Press Release.

NSW Government Department of Education. (2016). Learning modes [WWW Document]. https://education.nsw.gov.au/teaching-and-learning/curriculum/learning-for-the-future/future-focused-learning-and-teaching/learning-modes.

NSW Government Department of Education. (2017). School infrastructure NSW—at a glance [WWW Document]. https://education.nsw.gov.au/our-priorities/innovate-for-the-future/school-infrastructure-nsw-at-a-glance.

Organisation for Economic Co-operation and Development. (2017). The OECD handbook for innovative learning environments.

Patton, M. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks: Sage.

Philpott, C., & Oates, C. (2017). Professional learning communities as drivers of educational change: The case of learning rounds. *Journal of Educational Change, 18,* 209–234. https://doi.org/10.1007/s10833-016-9278-4.

Ritchie, J., Lewis, J., McNaughton Nicholls, C., & Ormston, R. (2014). *Qualitative research practice: A guide for social science students and researchers* (2nd ed.). Thousand Oaks: Sage.

Schaap, H., & de Bruijn, E. (2018). Elements affecting the development of professional learning communities in schools. *Learning Environments Research, 21,* 109–134. https://doi.org/10.1007/s10984-017-9244-y.

Stoll, L., Bolam, R. A. Y., McMahon, A., & Wallace, M. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7,* 221–258. https://doi.org/10.1007/s10833-006-0001-8.

Temple, P., & Fillippakou, O. (2007). Learning spaces for the 21 st century: A review of the literature. Centre for Higher Education Studies, University of London. Retrieved October 9, 2018 from https://www.heacademy.ac.uk/system/files/Learning_spaces_v3.pdf.

Toh, Y. (2016). Leading sustainable pedagogical reform with technology for student-centred learning: A complexity perspective. *J. Educ. Chang., 17,* 145–169. https://doi.org/10.1007/s10833-016-9273-9.

Ucci, M., Law, S., Andrews, R., Fisher, A., Smith, L., Sawyer, A., et al. (2015). Indoor school environments, physical activity, sitting behaviour and pedagogy: A scoping review. *Build. Res. Inf., 43,* 566–581. https://doi.org/10.1080/09613218.2015.1004275.

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