The empirical evaluation of the transition from traditional to New Generation Learning Spaces on teaching and learning

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The New Generation Learning Spaces (NGLS) project developed an empirical evidence-base to support the re-design of technology-enabled learning spaces, matched with a quasi-experimental evaluation of the effect on teaching and learning. This presentation will focus on the third stage of the NGLS study at the Anglican Church Grammar School (Churchie). The aim of this stage was to evaluate and understand the micro effects on teaching and learning that occur in the transition from a traditional classroom to a NGLS. A Single-Subject research design compared the activity and behaviour of the same teacher (n = 11) and class (n = 14) through a repeated measures paired-observation approach.

In a departure from traditional observational techniques, a novel observational metric was developed to produce real-time breakdown of activity across five domains (pedagogy, learning experiences, communities of learning and student and teacher use of technology). The metric's use was two-fold. Firstly, its instantaneous visual feedback provided an efficient medium for teachers to better understand their practice, and its affects on their students, in transition from traditional cellular spaces to the 'open studio' design of the NGLS. Secondly, the generation of empirical observational data enabled visual analysis of both individual teachers and faculty groupings through the spatial transition. This process identified functional changes and trends across the five domains, which were attributable to specific spatial elements of the NGLS design. This analysis provided an initial snapshot of how the affordances of different spaces, can shape the microelements of teacher and student activity and behaviour.

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Introduction

Interest in learning environments or spaces is a growing research field (Alterator & Deed, 2013; Cleveland & Fisher, 2014). This interest has seen the evolution of the term 'learning environments' to mean much more than the physical space in which learning takes place; to encompass both pedagogical and psychosocial elements of such environments (Jindal-Snape et al., 2013). Mulcahy (2015) has described how this interest has prompted a "re-consideration of learning and the spaces in which learning takes place" (p. 500). This interest has spanned from the appraisal of traditional designs through to suggestions of different models (Dovey & Fisher, 2014; Gislason, 2007). Dovey and Fisher (2014) suggested that the traditional 'cellular' classroom constrains the 'multiplicitous' nature of more student-centred pedagogies. To support these pedagogies, spaces need to be fluid and responsive in design and function (Alterator & Deed, 2013; Lippman, 2010). Also, Byers and Imms (2014) suggest that these spaces can better support the effective use of digital technology. These suggestions assume that a spatial change is an agent for pedagogical change (Oblinger, 2006).

This interest has coincided with significant innovation and investment in 'new' educational spaces (Dovey & Fisher, 2014). In their literature review, Blackmore, Bateman, O'Mara, and Loughlin (2011) noted that much of the research has concentrated on the physical aspects of the spatial design. Authors have established the specific environment conditions (i.e. air quality, lighting, noise, temperature, ventilation) optimal for student learning (Barrett & Zhang, 2009; Barrett, Zhang, Moffat, & Kobbacy, 2013). However, Blackmore et al. (2011) identified that this evidence base has yet to establish what happens once these new space are in use.

This imbalance in the evaluation of new space has been recognized by a number of authors (i.e. Blackmore et al., 2011; Hall-van den Elsen & Palaskas, 2014; Mulcahy, Cleveland, & Aberton, 2015). Barrett and Zhang (2009) identified this spatial transition from existing to new spaces as a "finished beginning" (p. iv). However, Hall-van den Elsen (2013) and Willis, Bland, Hughes, and Elliott Burns (2013) found little evidence examining the effects of this transition on teachers and students. Furthermore, Lackney (1998) is of the view that how teachers utlilise the affordances of these new spaces or their 'environmental competency' has been largely overlooked. Thus, it is unclear if, and how, this spatial change realizes its envisioned pedagogical change (Blackmore et al., 2011; Mulcahy et al., 2015; Willis et al., 2013).

This small study followed teachers through the transition from traditional to NGLS at the Anglican Church Grammar School (Churchie). The aim was to illuminate if a change in space correlated to any pedagogical change. A single-subject research design (SSRD) evaluated this transition using the Linking Pedagogy, Technology and Space (LPTS) real-time observation metric. The metric produced an empirical breakdown of teacher and student activity. Subsequent visual analysis identified the degree of an individual's pedagogical change through the spatial transition. The subsequent findings presented here found that there was a degree of pedagogical change associated with the spatial change. This novel approach has the potential to evaluate and track the pedagogical effect of different learning spaces. The longer-term pedagogical effects of a spatial transformation will be addressed in subsequent articles.

Background

The interest in redesigned spaces

The pedagogical effects of different learning spaces was acknowledged in the works of Dewey. Dewey (1916/2005) identified the mediating role of educative spaces in Democracy and Education. Dewey's philosophies informed the 'open-plan' classroom movement (1960s and 70s) and the post-war Reggio Emilia's early childhood movement

(Upitis, 2004). The former was the first significant top-down architerctural-inspired spatial departure from the cellular classroom developed during the Industrial Revolution (Lackney, 1998). Where as, the Reggio Emilia (similar to Frobel, Steiner and Waldorf) movements saw space as the "Third Teacher" and spoke more of a bottom-up user-orientated emphasis (Tarr, 2014; Upitis, 2004).

The affordances of new digital technologies and the re-emergence of student-centred pedaogies, has reignited the current interest in learning spaces (Dovey & Fisher, 2014). For too long the unconciousness regarding the power and influence of space, has seen the classroom environment become one of the few unchallenged and unchanged 'constants' in education (Fisher, 2004; Gislason, 2007; Scott-Webber, 2012). Rather than being tight, rigid and static containers (Brown, 2006; Fisher, 2006; McGregor, 2004b), there is a growing demand for spaces to perform pedagogically (Dovey & Fisher, 2014). Authors have suggested that the classroom is no longer a neutral setting, but an 'active agent' in the teaching and learning process (Burke, Grosvenor, & Norlin, 2014; Mäkitalo-Siegl, Zottman, Kaplan, & Fischer, 2010; Oblinger, 2006).

Growing attention about the design of classroom spaces has sought to connect spatial characteristics and technologies to particular pedagogies and learning experiences (Dovey & Fisher, 2014; Jindal-Snape et al., 2013; Upitis, 2004). Underlying this interest is the assumption that spaces are an embodiment of and mediate between specific definitions of learning (Gislason, 2007; Thomas, 2010). Even though spaces do not gesture, speak or think, there is the emerging view that their built pedagogy has the potential to 'shape' the behavioural, relational and social elements of teaching and learning (Gislason, 2007; Lefebvre & Nicholson-Smith, 1991; Massey, 1999; Melhuish, 2011; Monahan, 2002).

This requires spaces to act as a conduit for and be responsive to the dynamic convergence of social interactions, occupation and learning modalities (Dovey & Fisher, 2014; McGregor, 2004b; Thomas, 2010). Classrooms need to become less 'a' teacher space and a more a 'learners' space (Chandler, 2009). This requires spaces to be sympathetic to a more progressive view of learners as active, collaborative and constructive in their activities (Dovey & Fisher, 2014), and at the same time, provides for a much wider range of pedagogical practices (Mäkitalo-Siegl et al., 2010). These may range from teacher-centred direct instruction through to 'multiplicitous' pedagogies of student-centred learning (Dovey & Fisher, 2014).

The evaluation of classroom spaces

The evaluation of the potential effects of different learning spaces on teaching and learning is a deeply complex field (Boddington & Boys, 2011; Woolner, McCarter, Wall, & Higgins, 2012). For Gislason (2010) an underlying problem has been the delineation between the architectural and physical affordances of the spaces and the teaching and learning process. In a recent literature review, Cleveland and Fisher (2014) noted that authors in the learning environment research field have often focused on social or psychosocial environments (see Aldridge, Fraser, Bell, & Dorman, 2012; Dorman & Fraser, 2009; Zandvliet & Fraser, 2004). Cleveland and Fisher (2014) found that there were fewer studies that focused on the influence of the physical space on teaching and learning.

Much of the empirical research in the learning spaces field, has focused on the tangible aspects of the physical environment. Here it is commonly claimed that teachers' utilisation of space makes a difference to pedagogy, and therefore, must impact on student learning outcome (Joint Information Systems Committee, 2006). The recent works of Barrett et al. (2013) and Barrett and Zhang (2009) established those physical conditions (i.e. air quality, light, noise, spatial density, temperature and ventilation) that effect optimal teaching and learning. However, there is currently limited empirical evidence that has attempted to measure the effect of a spatial transformation on teacher behaviour and pedagogies and student learning outcomes (see for exceptions, Brooks, 2011; Byers & Imms, in press; Byers, Imms, & Hartnell-Young, 2014). Mulcahy et al. (2015) are of the view that this evaluation suggests a form of architectural determination, or a realist perspective, that seeks a direct causal link between space and its occupants.

How teachers and students utilise space as an element of the curriculum and how this shapes their behaviour remains an under-researched phenomenon (Blackmore et al., 2011; Chandler, 2009; Gislason, 2010; Higgins, Hall, Wall, Woolner, & McCaughey, 2005). Woolner, Hall, Higgins, McCaughey, and Wall (2007) are of the view that the take-up of the affordances of new learning spaces depends on teachers identifying and then exploiting this potential. This more relationalist perspective takes a contrary view to the modernist

(realist) view that there is a direct fit between space (existing and new) and its effects on its occupation (Boys, 2011; Mulcahy et al., 2015). Instead, Mulcahy et al. (2015) suggested that a relationalist perspective takes a mutually constitutive relationship between spaces and its use. For Blackmore et al. (2011) this indicates a need for greater emphasis on those intangible aspects of the ways that teachers and learners react, respond and use the spaces to enhance and optimise teaching and learning experiences.

Evidence of teacher change through spatial transition

The transition of teachers and students into new spaces can extend well beyond the initial 'inhabitation' (Blackmore et al., 2011). In their literature review, Blackmore et al. (2011) found the this transition from existing to new learning spaces has received limited attention in the literature. Hall-van den Elsen (2013) and Willis et al. (2013) also found little exploration of the effects of this transition on teachers and students. This touches on the view of Lackney (1998) that teachers' 'environmental competency', how teachers utlilise the affordances of space, has been largely overlooked to date.

This transition phase into a new building or space is incredibly important to its longer-term pedagogical success. For many teachers who are used to particular types of spaces (i.e. cellular or single spaces), effectively transitioning into using new spaces can be difficult (Blackmore et al., 2011). This spatial transition challenges the environmental competency of many teachers, to employ novel practices in unfamiliar spaces (Gislason, 2010; Higgins et al., 2005). Thomson, Jones, and Hall (2009) identify that there is a risk in teachers reverting to their "default pedagogies", at the expenses of any form of the pedagogical exploration and innovation.

The study

The aim of this study was to investigate if a spatial transformation from a traditional classroom to NGLS influenced the types of pedagogies, groupings and technologies used by teachers to create particular learning experiences. The hypothesis of this study was that different spatial layouts would have an effect and teacher behaviour and pedagogies and the learning experiences created. Hence, to understand this relationship further, what was of interest to this study is:

1. If you move a teacher and their students from a classroom that has a traditional layout to into a New Generation Learning Space (NGLS), how does this effect teacher behaviour through the types of pedagogies employed?
2. How do different spaces affect the types of learning experiences encountered by students?
3. How do different spaces effect how teachers groups students in different communities of learning (i.e. whole class, individual, small groups, mixed number groups and mixed class/ year levels)?
4. How do different spaces this move effect how teachers and students use different technologies (including digital and spatial)?

The spaces

The study took place in two existing conjoined buildings, which housed the Creative Arts (Drama, Film, Television and Media and Visual Art) Design and Technology (Design and Technology, Engineering and Technology studies) faculties. The original design of the buildings had specialist teachers in their specialist spaces. These specialist 'cellular' spaces were 'traditional' in layout, with furniture arranged in a fixed and rigid setting. This furniture faced the privileged 'fireplace' teaching position at the front of the room, delineated by a teacher desk, whiteboard and data projector screen (Reynard, 2009). The use of these spaces was often teacher-oriented and subject-specific, with little or no inter-disciplinary overlaps in teaching or learning.

The school had planned to refurbish the spaces, building on the earlier designs and findings of the Byers and Imms (2014) and Byers et al. (2014) studies. These studies explored and empirically evaluated how different spatial designs affected teaching and learning. This work had developed an evidence-base to support the re-design of other learning spaces in the school, matched with an evaluation of the effect of this change on pedagogies and learning experiences. The outcome of this research was the design and construction of the 'Creative Precinct'. The Creative Precinct brief was to bring the co-joined buildings and faculties into one dynamic and responsive pedagogical space.

Considerable teacher and key stakeholder consultation influenced the design of the Creative Precinct. This process identified a range of epistemological and pedagogical commonalities between the subjects; while these are multi-faceted, they centred on notions of design and creativity.

The consultation informed that architectural brief to create a space, which could bring the problem-solving and project-based nature embedded in these subjects together. The subsequent design employed an 'open-studio' approach. The aim was to allow students to occupy and transit between didactic teaching spaces, specialist technology-enabled workshop areas, and highly flexible inside and outside communal spaces. This dynamic cycle of occupation and transition intended to support students' transit through the intuitive creative process of conceptualization, design, creation, appraisal and refinement of their work. In this design it was conceived that students and teachers could enjoy easy access to Fisher (2006)'s three spatial modalities (mode 1 - teacher-centred; mode 2 - student-centred; and mode 3 - informal) in all learning spaces at all times. The design acknowledged the fact that technology mediated, creative learning occurred in a variety of settings, with a range of people (both staff and peers) and through a variety of modes.

A 'responsive design' approach enabled the space to shape the learning context of the student, and at the same time, enabled teachers to influence and mould the space to their pedagogical intent (Lippman, 2010). The aim was to support teachers too easily and efficiently transition between Fisher's modalities within the existing timetable lesson time. This was facilitated through a combination of flexible non-traditional furniture (e.g. raised tables and stools, booths and ottomans) integrated with more traditional desks and chairs to create a complete and interactive 360° or 'polycentric' learning environment (Dovey & Fisher, 2014; Miller-Cochran & Gierdowski, 2013). The intent of the polycentric layout was to de-emphasise the traditional front-focal point or 'fireplace' and to stimulate active teacher amd student movement around the various spaces (Lippman, 2013; Reynard, 2009). Now built, the studios and workshops did not resemble tight, static, hierarchical containers of learning of the past. Instead, they have become social and inviting spaces that encourage a convergence of expertise (student and teacher), pedagogy and technologies (both digital and equipment) throughout the building.

Research design

This study employed a Single-Subject research design (SSRD) to compare the activity and behaviour of the same teacher with the same class through a time-series quasi-experimental approach (Kratochwill, 2013). Each teacher acted as his or her own control, baseline and unit of analysis (Casey et al., 2012). A baseline/intervention (AB) design measured effect of a change in learning

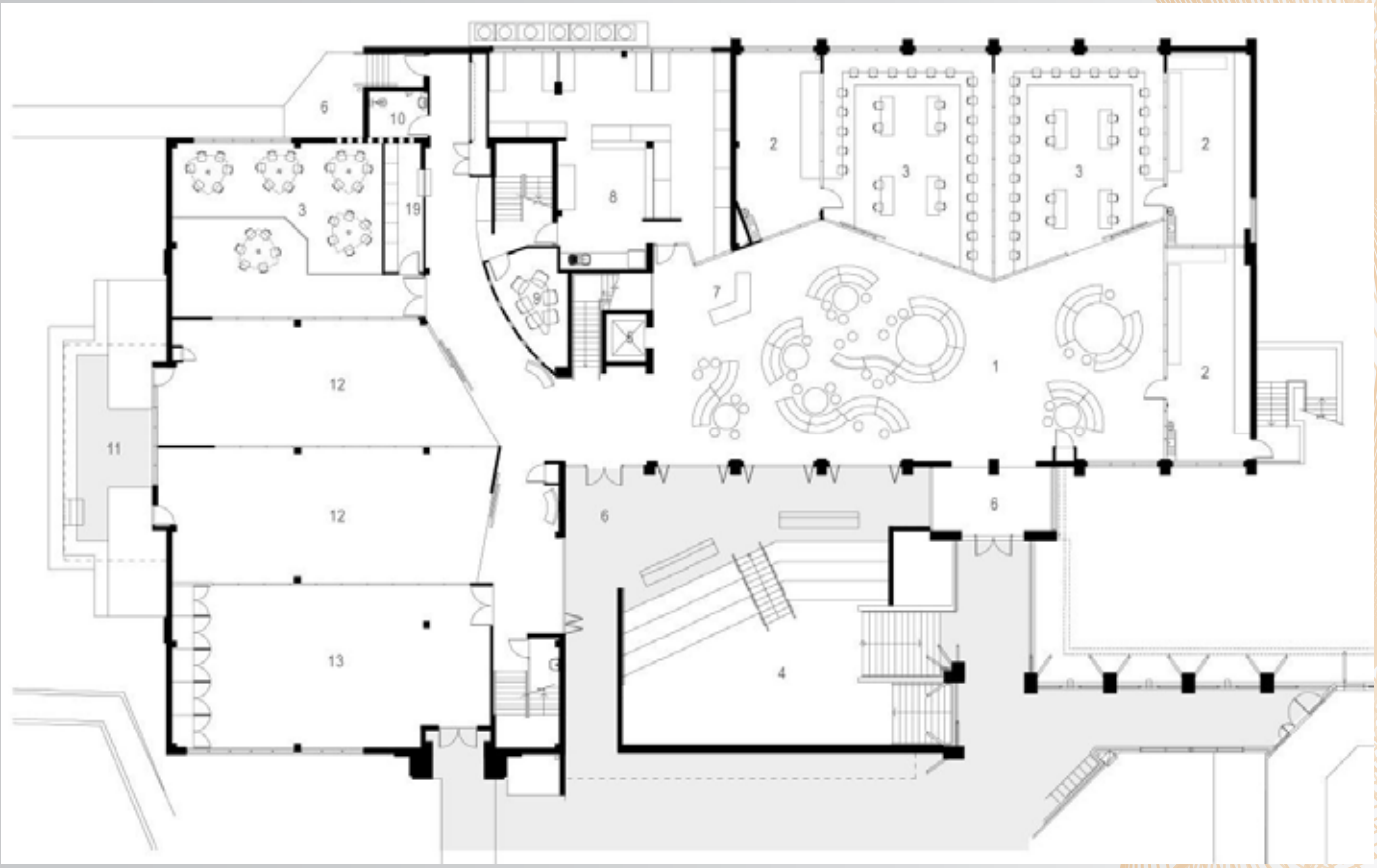

FIGURE 1 - *Hayward Midson Creative Precinct (NGLS) entry floor plan*

space (independent variable) on communities of learning, learning experiences, pedagogies and technology usage (dependent variables). The repeated measures paired-observation metric produced quantitative data of a subject's (student and teacher) activity. This time-series data was plotted and subjected to visual graphic analysis.

Sample

The sample consisted of consenting teachers (n = 11) from Design Technology (n = 6) and Visual Art (n = 5) Faculties. The sample consisted of teachers from the full spectrum of the Australian Professional Standards for Teachers Career Stage levels of Graduate (n = 2); Proficient (n = 5); Highly Accomplished (n = 3); and Lead (n = 2) (Australian Institute for Teaching and Leadership, 2015). Each of the participating teachers had some level of professional experience in their field prior to or in association with their teaching degree.

Method

The study employed the LPTS observational metric to analyse the behaviour of both teachers and students within the traditional (baseline) and NGLS (intervention) space. The LPTS metric times the activity and behaviours associated with five domains: pedagogy; learning experiences; community of learning; and student and teacher use of technology. A similar functionality was built into the International Society for Technology in Education (ISTE) Classroom Observational Tool (ICOT). The LPTS metric records, compiles and produces a proportionate breakdown of the observed lesson. For easy interpretation and comprehension, the LPTS metric is able to produce a single and/or paired observation visual breakdown in the form of bar graphs. In addition, the complication of numerous observations for the same teacher and Faculty enables efficient visual analysis.

Prior to the study, the LPTS metric was piloted with three observers. As recommend by Bielefeldt (2012), the chi-square frequencies on the ratings of 9 teachers (not participants in this study) were observed by each of the three observers on a total of 18 occasions. There were no statistically significant differences (p > .05) in the times recorded for the dimensions for each dependent variable. This pilot testing suggested the LPTS metric had adequate interrater reliability, similar to that of the original ICOT (Bielefeldt, 2012).

The time-series quasi-experimental design focused on establishing effective controls of confounding variables to maximise the study's internal validity (Gersten et al., 2005; Kratochwill, 2013). To control the variables of class composition and time of the school day, the LPTS was utilised to observe the same teacher, teaching the same class, during the same timetable period (school ran a fortnightly timetable cycle). To moderate the effect of the 'teaching and learning cycle', each teacher was observed three times prior to and post the spatial transition from traditional to NGLS. In addition, systematic sampling ensured adequate coverage of subjects and year-level. Therefore, three teachers (in the Visual Art Faculty) were observed teaching two different classes to ensure adequate subject and year-level coverage. This resulted in 84 observations (42 pre- and 42 post-intervention) recorded over a school semester (20 weeks).

To determine if the spatial transformation had any effect on teacher and student behaviour,

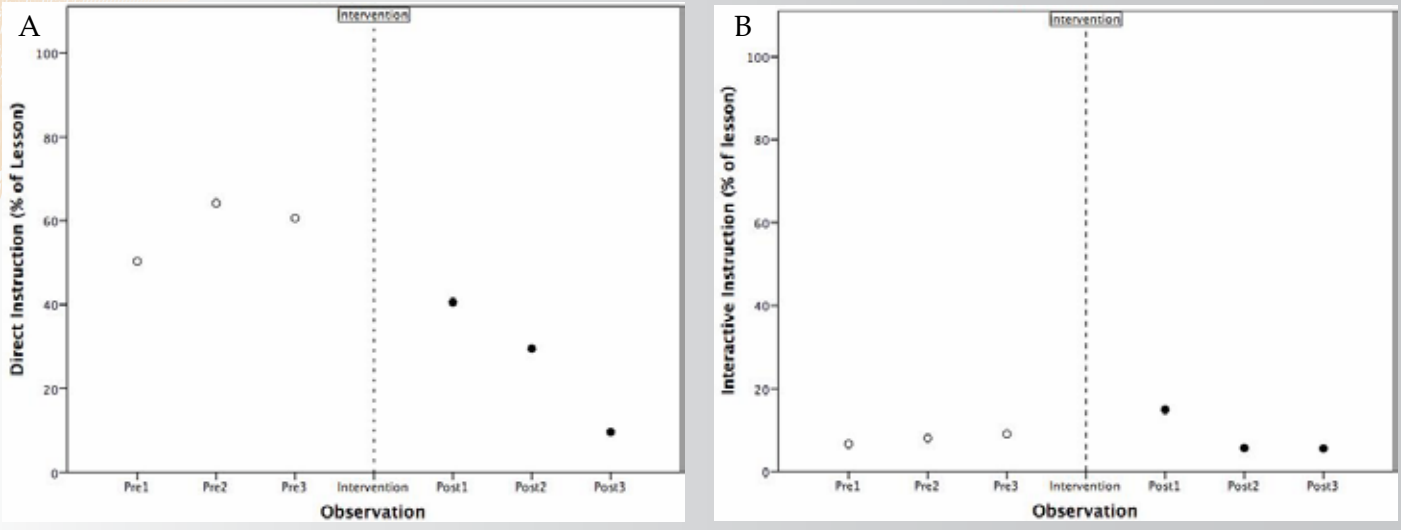

FIGURE 2 - *Application of visual analysis criterion to LPTS observational metric data*

analysis of the quantitative data from the LPTS metric was undertaken through visual analysis. The aim was to determine a functional relationship between the independent and dependent variables. The visual analysis criterion adapted from the literature (i.e. Byiers, Reichle, & Symons, 2012; Kratochwill, 2013) consisted of: level, trend, immediacy of the effect, and variability. Exemplars of the application of this criterion are provided in Figure 2. Panel A shows a clear and immediate difference between the baseline and intervention in level, with a decreasing (or negative) trend in the intervention phases. This analysis would suggest a functional change in teacher behaviour through the intervention phases. On the other hand, Panel B shows no visual difference (no functional change) between a stable (low variance) baseline and intervention period.

Results and discussion

Pedagogy

The pedagogy domain of the LPTS metric was comprised of the attributes: direct instruction, interactive instruction, facilitation, providing feedback, class discussion, and questioning. The most significant functional change through the spatial intervention was associated with the direct instruction attribute. The visual analysis identified that eight teachers had a function decrease in the proportion of time spent in a direct instruction mode through the spatial transformation. For these teachers, there was a general trend in increasing the proportion of the lesson that engaged more 'active' pedagogical modes (i.e. interactive instruction, facilitation and providing feedback). Interestingly, teachers appeared to swap overtly didactic modes of direct instruction, and increased instances of more interactive (i.e. hands-on demonstration) instruction in the NGLS. All teachers spent considerable time, throughout the study, engaged in the mode of facilitation. Teachers were generally assisting and observing students engaged in the 'creation' phase of teaching and learning sequence. However, there was an increase, but not significant, after the NGLS intervention. Finally, there was no functional change observed in the general low incidence of class discussion and questioning throughout the study.

Learning experiences

The learning experiences domain of the LPTS metric included the attributes: receive instruction, conceive, create, appraise, refine, drill and practice, hands-on and students disengaged. For the purposes of the metric, students disengaged was when more than a quarter of the observed class was off-task. There were significant functional change through the spatial intervention in a number of learning experience attributes. The students of 7 teachers spent significantly less time engaged in the learning mode of receiving instruction, which was correlated to the direct instruction pedagogical mode findings. There was significant positive increase in lesson time spent on students engaged in the higher-order activities of create, appraise and refinement. This was associated with a substantial increase in time spent by students engaged in hands-on or practical tasks. Interestingly, this shift to more hands-on and higher-order cognitive tasks resulted in a statistically significant decrease in time that students were disengaged or off-task. For all but one teacher, there was a significant visual decrease in the proportion of the lesson that their students were off-task post the spatial intervention. This trend warrants further investigation to determine if this change in student behaviour is due to the 'novelty' of a new environment, or alternatively, due to pedagogical changes made by their teacher/s.

Community of learning

The community of learning domain of the LPTS metric include the attributes: individual, group (same number), mixed groups (different numbers), whole class, mixed class, and mixed year-levels. Substantiating the trends in the direct and receive instruction pedagogical and learning modes, the time spent in a whole class and individual modes decreased in the NGLS. In the NGLS, there was a greater incidence of students working in groups. Of note, there was substantial increase in students working in various size or mixed groupings. Finally, the only teachers that embraced the concept of mixing classes or 'team teaching' were the Visual Art teachers. Through the spatial inte rvention, these teachers used the affordance of the open studio, to enable classes (of the same year level) to work together in a merged pedagogical space.

Student and teacher use of technology

The use of technology domain of the LPTS metric included both digital and spatial technological attributes. The aim was to observe how different spaces affected the use of different technologies. The most significant functional changed observed by teachers was the significant reduction in their use of digital technology (tablet PC and data projector) in a teacher-centric mode 1 layout. This would appear to corroborate the decrease in direct instruction observed in the pedagogy domain. This trend could suggest that teachers tended to use digital technology in the passive dissemination of content and information, which has been identified by Cuban, Kirkpatrick, and Peck (2001) and Cuban (2001).

All teachers after the intervention did increase the use the informal (mode 3) and spaces outside the timetabled space. The teachers utilised these additional spaces, whilst students were arranged in different size groupings. This appeared to assist in the facilitation of more differentiated student tasks. This increase in usage is significant, given that the design of the building was intended to facilitate this multi-use of space. This trend warrants further investigation to follow teachers' longer-term use of multiple spaces, beyond the initial spatial transformation.

For the students, there was significant increase in the use of digital and spatial technologies. The NGLS intervention was associated with a substantial increase in the use of their personal tablet PC and the application of CAD and multimedia software. In a similar vein to teachers, the students appeared to increase their occupation of informal and outside spaces. Rather than being confined to the same space at the same time, as observed in the traditional classroom, students occupied a greater range of spaces in the single lesson.

Conclusion

The current interest in and redevelopment of contemporary learning spaces has been driven by the premise that they will facilitate a desired pedagogical change. However, there has been limited empirical evidence showing how these spaces have realized this envisioned changed. This study attempted to illuminate how a spatial transformation, from traditional classrooms to NGLS, affected both teacher and student activity and behavior. The SSRD evaluated Design and Technology and Visual Art teachers through this transformation through the LPTS real-time observation metric.

The visual analysis of the metric's quantitative data identified that the change in space did change particular elements of teacher pedagogical practice and student activity. There was a general trend away from a high proportion of didactic and teacher-centric (mode 1) whole class instruction. After the NGLS intervention, this pedagogical mode was still observed, but much shorter and more focused in its intent. In its place was an increased prevalence of more active pedagogies facilitated in more informal (mode 3) arrangements. Teachers did utilise the affordances of multiple spaces to facilitate increased instances of student collaboration in mixed number groups. How teachers plan for and utilise this spatial affordance, in the longer term, warrants further exploration to determine the longer-term pedagogical effects.

This shift from teacher-centric to more student-centric pedagogies did have an effect on the types of student learning experiences observed. In the traditional classroom, learning was overtly a passive and sequential activity directed by the teacher. In the NGLS, there was a shift to more active pedagogies. There appeared to be greater levels of activity differentiation, in which, the students were engaged at different stages of the creative process. The teachers spent more time providing feedback (appraisal) and suggesting future direction (refinement) to individual and groups of students. The open studio design of the NGLS supported the effective and efficient movement of students through their activity in different spaces. Therefore, this observed change had a significant effect on reducing student distraction and off-task behaviours.

This study demonstrated how the affordances of different spaces, can shape the microelements of teacher and student activity and behaviour. These findings do suggest that the LPTS observation metric, analysed through a SSRD approach, has the potential to evaluate teacher and student experiences in different learning spaces. However, to improve the generality and validity of both the approach and the LPTS metric, a longer-term evaluation of teacher change and the effects of different contexts/spaces is required. Finally, subsequent article/s will focus on the longer-term effects of a spatial transformation on teacher behavior and pedagogies.

Reference List

Aldridge, J. M., Fraser, B. J., Bell, L., & Dorman, J. (2012). Using a new learning environment questionnaire for reflection in teacher action research. *Journal of Science Teacher Education, 23*(3), 259-290. doi: 10.1007/s10972-012-9268-1

Alterator, S., & Deed, C. (2013). Teacher adaptation to open learning spaces. *Issues in Educational Research, 23*(3), 315-330. doi: http://www.iier.org.au

Australian Institute for Teaching and Leadership. (2015). Australian Professional Standards for Teachers. Retrieved 21st June, 2015, from http://www.aitsl.edu.au/australian-professional-standards-for-teachers/standards/list

Barrett, P. S., & Zhang, Y. (2009). Optimal learning spaces: Design implications for primary schools. In S. Research, S. C. f. R. a. I. Report, University of Salford, Salford, viewed 12 September 2012. & <http://www.oecd.org/dataoecd/38/47/43834191.pdf> (Eds.).

Barrett, P. S., Zhang, Y., Moffat, J., & Kobbacy, K. (2013). A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning. *Building and Environment, 59*(0), 678-689. doi: http://dx.doi.org/10.1016/j.buildenv.2012.09.016

Bielefeldt, T. (2012). Guidance for technology decisions from classroom observation. *Journal of Research on Technology in Education, 44*(3), 205-223.

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.

Boddington, A., & Boys, J. (Eds.). (2011). *Re-shaping learning – An introduction*. Rotterdam: Sense.

Boys, J. (2011). Where is the theory? In A. Boddington & J. Boys (Eds.), *Re-Shaping Learning: A Critical Reader* (pp. 49-66). Rotterdam: Sense.

Brooks, D. C. (2011). Space matters: The impact of formal learning environments on student learning. *British Journal of Educational Technology, 42*(5), 719-726. doi: 10.1111/j.1467-8535.2010.01098.x

Brown, J. S. (2006). New learning environments for the 21st century: Exploring the edge. *Change: The Magazine of Higher Learning, 38*(5), 18-24.

Burke, C., Grosvenor, I., & Norlin, B. (Eds.). (2014). *Engaging with educational space: Visualizing spaces of teaching and learning*. Umeå Umeå University.

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 Conference Proceedings of the Australian Computers in Education Conference 2014.

Byers, T., & Imms, W. (in press). 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*. Amsterdam, Netherlands: Sense Publishers.

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. doi: 10.7459/ct/29.1.02

Byiers, B. J., Reichle, J., & Symons, F. J. (2012). Single-subject experimental design for evidence-based practice. *American Journal of Speech-Language Pathology, 21*(4), 397-414. doi: 10.1044/1058-0360(2012/11-0036)

Casey, L. B., Meindl, J. N., Frame, K., Elswick, S., Hayes, J., & Wyatt, J. (2012). Current trends in education: How single-subject research can help middle and high school educators keep up with the zeitgeist. *Clearing House: A Journal of Educational Strategies, Issues and Ideas, 85*(3), 109-116.

Chandler, W. L. (2009). "A" teacher space or a learner place?: Reconsidering the classroom environment. *International Journal of Learning, 16*(9), 261-267. doi: http://www.Learning-Journal.com

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

Cuban, L. (2001). *Oversold and underused: Computers in the classroom* Cambridge, Mass: Harvard University Press.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*(4), 813. doi: 10.2307/3202504

Dorman, J., & Fraser, B. (2009). Psychosocial environment and affective outcomes in technology-rich classrooms: Testing a causal model. *Social Psychology of Education, 12*(1), 77-99. doi: 10.1007/s11218-008-9069-8

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *The Journal of Architecture*, 1-21. doi: 10.1080/13602365.2014.882376

Fisher, K. D. (2004). Revoicing classrooms: A spatial manifesto. *Forum, 46*(1), 36-38.

Fisher, K. D. (2006). The new learning environment: Hybrid designs for hybrid learning. http://www.woodsbagot.com/en/Documents/Public_Research/PUBLIC2%20The%20New%20Learning%20Environment.pdf

Gersten, R., Fuchs, L. S., Compton, D., Coyne, M., Greenwood, C., & Innocenti, M. S. (2005). Quality Indicators for Group Experimental and Quasi-Experimental Research in Special Education. *Exceptional Children, 71*(2), 149-164.

Gislason, N. (2007). Placing education: The school as architectural space. *Paideusis, 16*(3), 5-14.

Gislason, N. (2010). Architectural design and the learning environment: A framework for school design research. *Learning Environments Research, 13*(2), 127-145. doi: 10.1007/s10984-010-9071-x

Hall-van den Elsen, C. (2013). The impact of new learning spaces on teaching practice. Melbourne: RMIT University.

Hall-van den Elsen, C., & Palaskas, T. (2014). Transition to next generation learning spaces. In K. Fraser (Ed.), *The future of learning and teaching in next generation learning spaces* (Vol. 12, pp. 199-218): Emerald Group Publishing Limited.

Higgins, S., Hall, E., Wall, K., Woolner, P., & Mc-

Caughey, C. (2005). *The impact of school environments: A literature review.* Newcastle, United Kingdom.

Jindal-Snape, D., Davies, D., Collier, C., Howe, A., Digby, R., & Hay, P. (2013). The impact of creative learning environments on learners: A systematic literature review. *Improving schools, 16*(1), 21-31. doi: 10.1177/1365480213478461

Joint Information Systems Committee. (2006). Designing spaces for effective learning: A guide to 21st century learning space design. www.jisc.ac.uk/media/documents/publications/learningspaces.pdf

Kratochwill, T. R. (2013). *Single subject research: Strategies for evaluating change*. Burlington Elsevier Science.

Lackney, J. A. (1998). *Changing patterns in educational facilities.* Paper presented at the REFP Workshop conducted at the CEFPI 1998 Conference, Vancouver.

Lefebvre, H., & Nicholson-Smith, D. (1991). *The production of space* (Vol. 30). Oxford: Blackwell

Lippman, P. C. (2010). Can the physical environment have an impact on the learning environment? *CELE Exchange. Centre for Effective Learning Environments, 2010*(11-14), 1-5.

Lippman, P. C. (2013). Designing collaborative spaces for schools: Part 1. *The Journal, January*. http://thejournal.com/articles/2013/02/13/designing-collaborative-spaces-for-schools.aspx

Mäkitalo-Siegl, K., Zottman, J., Kaplan, F., & Fischer, F. (2010). The classroom of the future - An introduction. In K. Mäkitalo-Siegl, J. Zottman, F. Kaplan & F. Fischer (Eds.), *Classroom of the future: Orchestrating collaborative spaces* (pp. 1-14). Rotterdam: Sense Publishers.

Massey, D. (1999). *Power-geometries and the politics of space-time*. Paper presented at the Hetter Lecture, Heidelberg.

McGregor, J. (2004b). Space, power and the classroom. *Forum, 46*(1), 13-18.

Melhuish, C. (2011). Methods for understanding the relationships between learning and space. In A. Boddington & J. Boys (Eds.), *Re-Shaping Learning: A Critical Reader* (pp. 19-31). Rotterdam: Sense Publishers

Miller-Cochran, S., & Gierdowski, D. (2013). Making peace with the rising costs of writing technologies: Flexible classroom design as a sustainable solution. *Computers and Composition, 30*(1), 50-60.

Monahan, T. (2002). Flexible space & built pedagogy: Emerging IT embodiments. *Inventio, 4*(1), 1-19.

Mulcahy, D. (2015). Re/assembling spaces of learning in Victorian government schools: Policy enactments, pedagogic encounters and micropolitics. *Discourse: Studies in the Cultural Politics of Education, 36*(4), 500-514.

Mulcahy, D., Cleveland, B., & Aberton, H. (2015). Learning spaces and pedagogic change: envisioned, enacted and experienced. *Pedagogy, Culture & Society*, 1-21. doi: 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). Retrieved from http://net.educause.edu/ir/library/pdf/PUB7102.pdf.

Reynard, R. (2009). *Designing learning spaces for instruction, not control*. Campus Technology.

Scott-Webber, L. (2012). Institutions, educators, and designers: Wake up!: Current teaching and learning places along with teaching strategies are obsolete-teaching styles and learning spaces must change for 21st-century needs. *Planning for Higher Education, 41*(1), 265-277. doi: http://www.questia.com/read/1G1-325092242/institutions-educators-and-designers-wake-up-current

Tarr, P. (Ed.). (2014). *If the environment is the third teacher, what is it teaching us?* New York: Teachers College Press.

Thomas, H. (2010). Learning spaces, learning environments and the dis'placement' of learning. *British Journal of Educational Technology, 41*(3), 502-511.

Thomson, P., Jones, K., & Hall, C. (2009). Creative school change research project. *Arts Council England*. http://www.aspire-trust.org/wordpress/wp-content/uploads/2013/10/creative-school-change-final-report-nov-2009-184.pdf

Upitis, R. (2004). School architecture and complexity. *Complicity: An International Journal of Complexity & Education, 1*(1), 19-38.

Willis, J., Bland, D., Hughes, H., & Elliott Burns, R. (2013). *Reimagining school libraries: Emerging teacher pedagogic practices*. Paper presented at the AARE 2013 International Conference of The Australian Association for Research In Education, Adelaide.

Woolner, P., Hall, E., Higgins, S., McCaughey, C., & Wall, K. (2007). A sound foundation? What we know about the impact of environments on learning and the implications for building schools for the future. *Oxford Review of Education, 33*(1), 47-70. doi: 10.1080/03054980601094693

Woolner, P., McCarter, S., Wall, K., & Higgins, S. (2012). Changed learning through changed space: When can a participatory approach to the learning environment challenge preconceptions and alter practice? *Improving schools, 15*(1), 45-60. doi: 10.1177/1365480211434796

Zandvliet, D. B., & Fraser, B. J. (2004). Learning environments in information and communications technology classrooms. *Technology, Pedagogy and Education, 13*(1), 97-123. doi: 10.1080/14759390400200175