ACEC2014 - MAKING THE SPACE FOR SPACE: THE EFFECT OF THE CLASSROOM LAYOUT ON TEACHER AND STUDENT USAGE AND PERCEPTION OF ONE-TO-ONE TECHNOLOGY

Terry Byers

Anglican Church Grammar School

Wes Imms

The University of Melbourne

Abstract

Today, a significant proportion of Australian secondary school students have some level of access to digital technology through one-to-one or BYOD programs. This ubiquitous access to devices connected through wireless network can create a technology-enabled learning environments (TELE). The teacher-student connectivity of a TELE has the potential to facilitate more collaborative and responsive learning experiences in modalities that may have not been possible before. Despite these significant changes, many students occupy classroom spaces that have changed little in configuration, structure and operation.

This paper reports on the first stage intervention of a three stage quasi-experimental study. The study explored the synergy between technology-enabled and responsive learning spaces and its effects on teaching and learning in a Secondary school setting. The stage one intervention sought to determine if a causal relationship existed between particular layouts and how teachers' and students' perceived the incidence in usage and the influence and effectiveness of one-to-one technology.

A single-subject research design (SSRD) measured the effect of two types of classroom layouts through an explanatory mixed method design. Results from quantitative analyses over a one-year period indicated a more responsive and dynamic physical learning space did have a positive effect on student perceptions of the effectiveness and influence of one-to-one technology on their learning. These quantitative findings were corroborated through thematic analysis of teacher focus groups. Collectively this evidence suggests that the arrangement of the physical learning space can assist teachers to better integrate the affordances of technology into their pedagogical practice.

Introduction

Student access to and usage of digital technology brought about by one-to-one or BYOD programs has the potential to offer many avenues to improve teaching and learning. This ubiquitous access to digital technology through one-to-one devices connected through wireless infrastructure can create technology-enabled learning environments (TELE). The connectivity associated with TELE can support collaborative and more responsive learning experiences by connecting teachers and students in modalities that may have not been possible before (Rosen & Beck-Hill, 2012). The affordances associated with this environment can support contemporary pedagogical practices that are believed to be most powerful in facilitating personalised

models of student learning (Bocconi, Kampylis, & Punie, 2012; Ertmer & Ottenbreit-Leftwich, 2010). Despite these significant changes Bautista and Borges (2013) and Chandler (2009) argue that many students operate in a traditional classroom space that has changed little in configuration, structure and operation.

The traditional layout is typical of a classroom where students are arranged in fixed instruction settings, facing the teacher at the front-centre focal or display point (Chandler, 2009; Reynard, 2009). Richards (2006) argues too often the integration of technology into these spaces has been an afterthought, predominantly added-on to existing structures. This approach characteristically leads to the technology supporting existing pedagogical modes (Richards, 2006; Rosen & Beck-Hill, 2012). Fisher (2010) agrees that this lack of alignment between the possible affordances associated with technology and the common traditional fixed instructional setting points to a *deep spatial silence*. This silence is key to understanding how the salient effects of physical learning environments is enabling or restricting the implementation of technology to support more contemporary pedagogical practices (Fisher, 2004; Lippman, 2010).

This paper seeks to show how the physical arrangement of the space can either hinder or support the effective use of one-to-one technology. It reports on a *Single Subject Research Design* (SSRD) study that measured the quantitative effect of two classroom layouts on how teachers and students perceived the incidence in usage, influence and effectiveness of one-to-one technology. These quantitative findings, further justified by thematic analysis of a teacher focus group, sought to determine if a causal relationship exists between particular layouts and how teachers and students perceived the incidence in usage and the influence and effectiveness of one-to-one technology. This study, whilst small in scale, models an approach with the potential to add dramatically to previously overlooked structures that can support the adoption and effectiveness of one-to-one technology.

Literature Review

The built pedagogical contract of the traditional classroom

The physical layout of the space contains implicit and explicit physical and psychological cues. These cues instinctively and visibly instruct both teachers and students how to behave within the space (Cleveland, 2011; Monahan, 2002). In a classroom that is typical of a traditional layout, these cues are evident in juxtaposition

of teachers and students. The teacher's front-centre position, reinforced by a desk and visual display is directly opposed to students arranged in a fixed instructional setting. The teacher's positioning, establishes what Reynard (2009) describes as the *fireplace syndrome*. It sets clear expectations of the role of the teacher and students in the transmission of knowledge (Reynard, 2009). Over time this behaviour estatablishes a certain script for the teaching and learning transaction between teachers and students (Cleveland, 2011; Dovey & Fisher, 2014).

The establishment of this consistent pedagogical script overtime is best described by the concept pf *built pedagogy* developed by Monahan (2002). Built pedagogy describes the ability of the obvious and salient characteristics of the physical space to shape teacher practice and student learning. This is evident in the preservation of the traditional classroom archetype beyond the learning and pedagogical theories that it was initially designed to facilitate (Dovey & Fisher, 2014; Hildebrand, 1999). The result is a hidden *built pedagogical contract* which sets the tone of the teaching and learning relationship between student(s) and teacher(s) (Hildebrand, 1999). Hildebrand (1999) argues that any transgression from the conventions and/or the prevailing norms of this contract, results in resistance from one or both parties. Fullan, Hill, and Crevola (2007) describes how this resistance could be responsible for the classroom innately perpetuating resident pedagogical culture within schools to maintain the status quo.

Rationale for the synergy of space and technology

Brown and Long (2006) and Fisher (2006) argue that learning spaces need to become much more than just tight, static, hierarchical containers of learning. Instead, Oblinger (2005) indicates that spaces should act as a conduit that enable the convergence of technology and pedagogy. This translates to designs that must embody spatial qualities that enable technology to support current and evolving pedagogical practices (Fisher, 2006; Joint Information Systems Committee, 2006). At the same time, the design, configuration and utilisation of spaces must adapt to and in turn be shaped by the users of the space.

Dovey and Fisher (2014) describe how the interaction between the users of the space, the technology (furniture and digital) and the physical layout must enable continual adaptation and flow between various pedagogical and learning modes (teacher-centred, student-centred and informal). This requires spaces to be more than

just flexible in design. Instead Kolb (2005) and Lippman (2010) suggest the emphasis should be on *responsive* design that enables the space to shape the learning context of the inhabitants, and at the same time, enable these inhabitants influence, moulding the space to their pedagogical intent. The result is spaces that are able to adapt to and accommodate emerging modalities, pedagogy and digital technologies.

The Study

Currently there is limited understanding about the interplay between technology-enabled and responsive learning spaces and how this can affect teacher and student usage and perceived value of one-to-one technology. The present study explored how the physical arrangement of the space of different classroom layouts hindered or supported the effective use of digital technology in a secondary school environment. The aim was to determine if a causal relationship existed between particular layouts and how teachers and students perceived the incidence in usage and the influence and effectiveness of one-to-one technology. It was hypothesised that a more responsive and dynamic physical learning space will better support the affordances of one-to-one technology.

The Spaces

The two classroom types existed within buildings constructed between 1940 and 1960. The first type is typical of a classroom that would be described *traditional* in layout. Desks and chairs are set in a fixed instructional setting, facing a front-centre focal point or teaching position. The second type of classroom is a retrofitted *new generation learning space* (NGLS). A NGLS combines the flexibility of furniture design and use with the integration of digital and visual technologies to create a dynamic and interactive 360° or *polycentric* learning space (Lippman, 2013; Monahan, 2002). The aim of this combination was to break down the traditional fixed instruction setting by enabling flow between various pedagogical and learning modes within the existing room.

The polycentric layout was to be created using large TVs on Walls/Wheels, or TOWs, *Writeable Walls* and multiple teacher data projector inputs (Lippman, 2013; Miller-Cochran & Gierdowski, 2013). This layout has been successfully used in: North Carolina State University's SCALE-UP, Massachusetts Institute of Technology's TEAL and University of Minnesota's ALC projects. Each of these initiatives sought to breakdown the entrenched fireplace syndrome through the de-

emphasis on the front-centre focus (Miller-Cochran & Gierdowski, 2013; Reynard, 2009). This supported the shift away from highly teacher-centred, verbal-linguistic learning, to more collaborative, active and student-centred learning approaches.
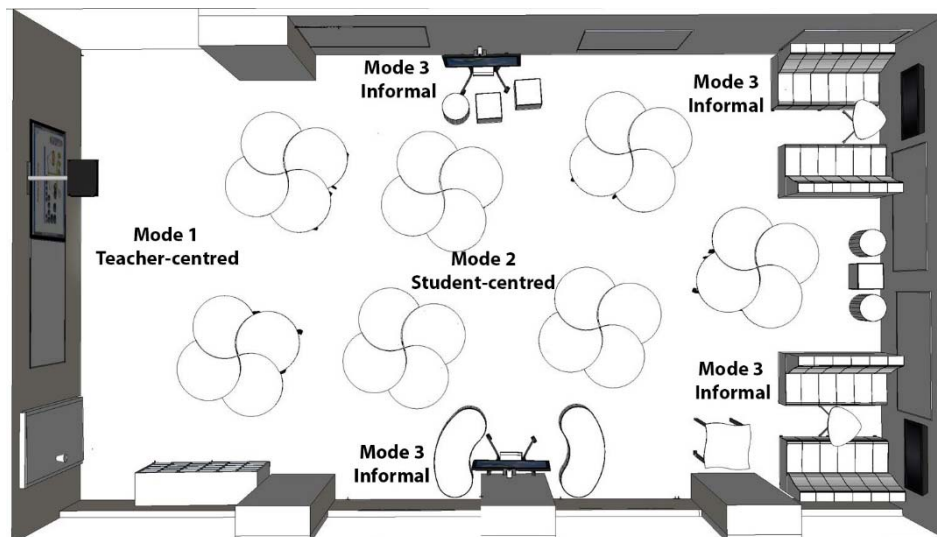

Figure 1. New generation learning space (NGLS) polycentric layout

The Research Design

The aim of the study was to determine if a causal relationship existed between the intervention, the change in classroom type (independent variable), and how students perceived the incidence in usage and the influence and effectiveness of one-to-one technology (dependent variables). The recommendations of Campbell (1957) and Shadish, Cook, and Campbell (2002) around causal inference was employed to ensure the research design had strong focus on moderating the *plausible* threats to internal validity and the spurious effect of confounding variables. However, the nuances of the schooling environment did not support the random assignment and absolute variable control that is a requisite of a randomised experimental study. As a consequence, this study synthesised elements from quasi-experimental and SSRD approaches to moderate these threats and effects.

A quasi-experimental design is a well-established approach to non-randomised intervention studies (Harris et al., 2006). A key facet of quasi-experimental studies is the emphasis on the design, rather than statistics alone, to facilitate causal inference (Shadish & Cook, 1999). This study implemented a design that was able to control a raft of confounding variables, except for the change in classroom type. The confounding causal variables that were controlled included the

teacher, student cognitive ability, class composition and subject type. This variable control was facilitated through the application of a SSRD.

Romeiser Logan, Hickman, Harris, and Heriza (2008) and Horner et al. (2005) argue that SSRD is a rigorous and reliable means of moderating the plausible threats to internal validity and variability. It achieves this through establishing a functional relationship between the manipulation of the intervention and the subsequent effect on the dependent variables (Horner et al., 2005). This relationship was facilitated through the study of the six participating classes, who acted as their own control, baseline and unit of analysis (Cakiroglu, 2012; Horner, Swaminathan, & George, 2012). With each class compared and contrasted against themselves, this negated the threat of between-subject variability (Horner et al., 2005). It also mitigated the internal validity threats of selection and testing (Campbell, 1957). The addition of a time-series component to the research design moderated the internal validity threats of maturation and history (Shadish et al., 2002).

A baseline/intervention (A/B) design, collected empirical data through an explanatory mixed method across three baseline (traditional) and four post-intervention (NGLS) points. The aim was to establish a stable baseline for each class, to further strength the validity of the study. This would mitigate the effect of within-subject variability to correlate (Romeiser Logan et al., 2008). In addition, this correlates the causality between the changes in dependent variables to the effect of the particular intervention (Shadish et al., 2002). This collectively seeks to overcome the difficulty to establish singular causality, which is a general criticism of an SSRD.

Data Analysis

Data was collected through a repeated-measures student attitudinal five point Likert scale survey. To improve the generalisability of findings, questions were incorporated from the Shear, Means, Gallagher, House, and Langworthy (2009) *Microsoft Partners in Learning Innovative Teaching and Learning* survey instrument. Questions relating specifically to dependent variables of the influence, effectiveness and incidence use of technology were utilised, but rewritten to be suitable for the research context and age of participants. For example, the question 'This space improves the effectiveness of technology as a learning tool' correlated to the dependent variable of effectiveness.

The survey had high, but not perfect, retention rates (96.7%). To alleviate within-subject variability the statistical power of the sample size ($n = 164$) was maintained by the application of Maximum Likelihood Estimation (ML) to produce a complete data set. ML was chosen because it does not artificially truncate the variance and covariance around the mean (Peugh & Enders, 2004). This truncation would abbreviate the 95% confidence intervals about the mean that would negatively bias the determination of statistical significance that would inform causal inference (Peugh & Enders, 2004). This decision was justified by the data set having Little's Missing Completely at Random (MCAR) score greater than 0.05 (0.94).

A Cronbachs Alpha (0.86) enabled each class's data to be summed and treated as single subject (Ivankova, Creswell, & Stick, 2006). Consequently the visual analysis of class means, with 95% confidence intervals, evaluated the *true effect* of the intervention by indicating the plausible range of values to identify inter- and intra-intervention trends (Baguley, 2009). Bobrovitz and Ottenbacher (1998) claim that this process is equitable for *t*-test calculations.

To mitigate the *subjective* nature of visual analysis and Type 1 errors, additional quantitative analysis and thematic analysis of teacher focus groups occurred (Kinugasa, Cerin, & Hooper, 2004). Cohen's *d* effect size calculations, were calculated using the method suggested by Beeson and Robey (2006). This circumvented distributional issues of inferential statistics to justify the determination of statistical significance (Beeson & Robey, 2006). Finally thematic analysis of a follow-up teacher focus group provided a more detailed and context-specific picture that explained to some degree particular statistical results and outcomes.

Analysis of Student Attitudinal Survey

The visual analysis process outlined by Horner et al. (2012) was utilised to determine *significant* and *non-significant* statistical difference (Figure 2). This process incorporated the criterion of changes in level, trend and variability of both means and confidence intervals. The shift from a traditional to NGLS classroom resulted in a clear statistical difference in twelve out of the eighteen questions (Table 1). Figure 2 indicates the reliability of visual analysis in moderating both the trend and variability to determine statistical significance. The stable baseline set of class 8.2, along with non-overlapping confidence intervals of a stable intervention phase, indicates a statistically significant change, attributable to the NGLS intervention.

Whereas, the unstable and positive trending baseline data set of class 7.2 and overlapping confidence interval indicates a positive, but not statistically significant change.
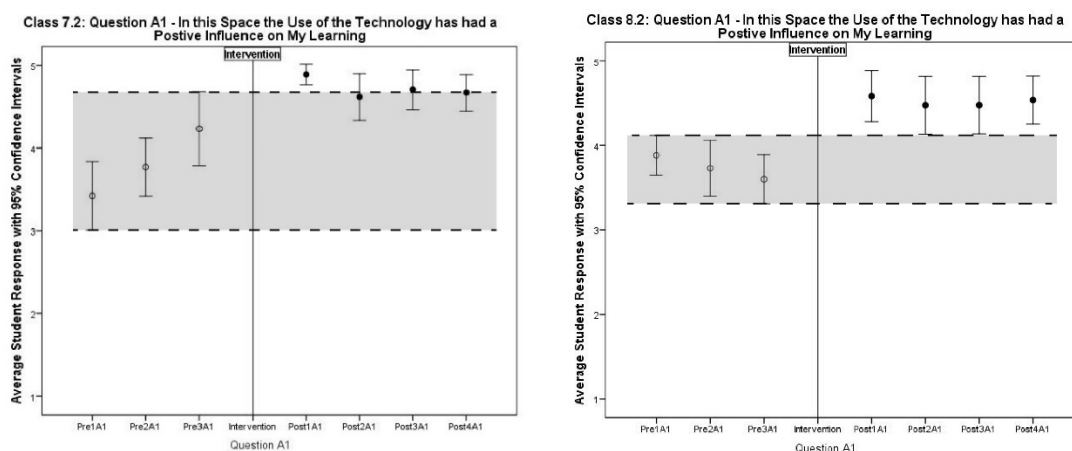

Figure 2. Visual analysis through summative means, with 95% confidence intervals, of attitudinal data in a traditional and NGLS classroom

Cohen's *d* effect sizes (Table 1) were calculated using the process outlined by Beeson and Robey (2006). All pre- and post-measures were utilised in the effect size calculation, to ensure a more reliable representation than a single measure. Using the thresholds suggested by Cohen (1998), the conclusions made from the visual analysis are justified through large (0.8 to 1.3) to very large (greater than 1.3) effect sizes. Interestingly, class 7.2 achieved a slightly larger effect size for Question A1 than class 8.2, even though the visual analysis process identified a statistically significant effect in class 8.2. This supports the robustness of visual analysis, as it distinguishes not only a change in level, but also the variation and trends throughout both phases.

Table 1

Summary table of visual analysis and effect size calculations for the positive influence, effectiveness, and flexibility of one-to-one technology

Class	Positive influence		Effectiveness		Flexibility	
	Visual analysis	Cohen's d effect size	Visual analysis	Cohen's d effect size	Visual analysis	Cohen's d effect size
7.1	Significant	1.291	Significant	2.016	Significant	1.203
7.2	Non-significant	1.131	Significant	1.527	Non-significant	0.737
8.1	Non-significant	0.931	Significant	1.37	Non-significant	0.793
8.2	Significant	1.055	Significant	1.57	Significant	1.114
8.3	Non-significant	0.721	Significant	1.81	Non-significant	0.665
8.4	Significant	1.634	Significant	2.495	Significant	1.211

Thematic Analysis of Teacher Focus Group

Thematic analysis of a teacher focus group followed the quantitative analysis. All teachers noted that the change from a traditional classroom to NGLS layout coincided with a change in both teacher and student perception of the value of technology. Teacher B noted that "I think there's a bit of a myth out there that, the one-to-one program is invalid, that technology gets in the way, it doesn't actually help deliver the curriculum". There was agreement that teachers' perceptions and beliefs had a significant effect on how they viewed the relevance of technology. Furthermore that the application of the one-to-one Tablet PC program is limited more by the teachers and that the students are ready for change. This is corroborated by the student data indicating that all classes identified that they perceived the technology was a more effective learning tool in a NGLS compared to a traditional classroom.

The teachers noted that one of these reasons for the change in both perception and usage was due to the flexibility and collaborative nature of the NGLS. This was supported by various comments that highlighted how the flexibility of the room enabled them to use a wider range of software applications. Teacher A noted by the "end of the survey period I was actually doing a lot more with the technology… and using it quite extensively". This increase usage of a range of software applications in

an NGLS was verified by medium to large effect sizes in the student data associated with the intervention.

This use of a wider variety of software applications, along with the flexibility of an NGLS, had a significant effect of the pedagogical activities that the technology supported. For example, Teacher C noted that they "deliberately tried to get the boys to use technology in different ways within the new rooms". Rather than just using the technology to disseminate information and content, a significant number used applications that connect students into various sized groupings to facilitate collaboration. For example Teacher A noted that across Year 7 "changes were made to various activities and assessment to incorporate a higher degree of student collaboration". This collaboration initially took place face-to-face in the NGLS, but was extended outside the classroom through the key applications of Shared OneNotes and Web 2.0 tools.

Conclusion

In summary, the study found sound quantitative evidence that the arrangement of the physical learning space does have an effect on how teachers and students perceive the influence, effectiveness, and teacher usage of one-to-one. This was determined through a combination of visual analysis and effect-size calculations of SSRD data as a suitable and robust mechanism in the determination of a statistically significant effect of an intervention. In all instances, a statistically significant result determined through visual analysis, was justified by a large to very large effect size. Thematic analysis of the teacher focus group provided an additional layer of context-specific and reliable detail. The corroborating nature of the teacher voice did support the statistical analysis and subsequent conclusion derived from the student data. Both the student and teacher data does suggest that when the layout of the classroom aligns with and supports the affordances and flexibility associated with technology, its perceived influence, effectiveness, and flexibility improves. Therefore, this lack of alignment between the arrangement of the physical learning space and the affordances of one-to-one technology appears to be a potential barrier, not widely acknowledged, for teachers in the effective and efficient use of technology.

Reference List

Baguley, T. (2009). Standardized or simple effect size: What should be reported? *British Journal of Psychology, 100,* 603-617. doi: 10.1348/000712608X3771 17

Bautista, G., & Borges, F. (2013). Smart classrooms: Innovation in formal learning spaces to transform learning experiences. *Bulletin of the IEEE Technical Committeee on Learning Technology, 15*(3), 18-21. doi:http://lttf.ieee.org/

Beeson, P. M., & Robey, R. R. (2006). Evaluating single-subject treatment research: Lessons learned from the aphasia literature. *Neuropsychology Review, 16*(4), 161-169. doi: 10.1007/s11065-006-9013-7

Bobrovitz, C. D., & Ottenbacher, K. J. (1998). Comparison of visual inspection and statistical analysis of single-subject data in rehabilitation research. *American Journal of Physical Medicine and Rehabilitation, 77*(2), 94-102. doi: www.journals.lww.com

Bocconi, S., Kampylis, P. G., & Punie, Y. (2012). Innovating learning: Key elements for developing creative classrooms in europe. Luxembourg: Joint Research Centre for the European Commission.

Brown, M., & Long, P. (2006). Trends in learning space design. In D. G. Oblinger (Ed.), Learning spaces (pp. 9.1 - 9.11). Washington D.C: EDUCAUSE. Retrieved from http://net.educause.edu/ir/library/pdf/PUB7102.pdf. doi: http://www.educause.edu

Cakiroglu, O. (2012). Single subject research: Applications to special education. *British Journal of Special Education, 39*(1), 21-29. doi: 10.1111/j.1467-8578.2012.00530.x

Campbell, D. T. (1957). Factors relevant to the validity of experiments in social settings. *Psychological Bulletin, 54*(4), 297-312. doi: doi:10.1037/h0040950

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

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

Cohen, J. (1998). *Statistical power analysis for the behavioral sciences* (2nd ed.). Erlbaum: New Jersey.

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

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education, 42*(3). doi: www.iste.org

Fisher, K. D. (2004). Revoicing classrooms: A spatial manifesto. *Forum, 46*(1), 36-38. doi: http://dx.doi.org/10.2304/forum.2004.46.1.8

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

Fisher, K. D. (2010). Technology-enabled active learning environments: An appraisal. *CELE Exchange. Centre for Effective Learning Environments, 2010*(6-10), 1-8. doi: http://dx.doi.org.ezp.lib.unimelb.edu.au/10.1787/5kmbjxzrmc0p-en

Fullan, M., Hill, P., & Crevola, C. (2007). *Breakthrough*. Victoria: Hawker Brownlow Education.

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association, 13*(1), 16-23. doi: 10.1197/jamia.M1749

Hildebrand, G. M. (1999). *Con/testing learning models*. Paper presented at the Australian Association for Research in Education and New Zealand Association for

Research in Education Conference, Melbourne.

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*(2), 165-179.

Horner, R. H., Swaminathan, H. S., & George, S. K. (2012). Considerations for the systematic analysis and use of single-case research. *Education and Treatment of Children, 35*(2), 269. doi: 10.1353/etc.2012.0011

Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods, 18*(1), 3-20. doi: 10.1177/1525822X05282260

Joint Information Systems Committee. (2006). Designing spaces for effective learning: A guide to 21st century learning space design. *Higher Education Funding Council for England (HEFCE) on behalf of JISC*.

Kinugasa, T., Cerin, E., & Hooper, S. (2004). Single-subject research designs and data analyses for assessing elite athletes' conditioning. *Sports Medicine, 34*(15), 1035-1050. doi: 10.2165/00007256-200434150-00003

Kolb, A. Y. K., D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning and Education, 4*(2), 193-212. doi: 10.2307/40214287

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. doi: 10.1787/5km4g21wpwr1-en

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

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. doi: 10.1016/j.compcom.2012.12.002.

Monahan, T. (2002). Flexible space & built pedagogy: Emerging IT embodiments. *Inventio, 4*(1), 1-19. doi: http://www.torinmonahan.com

Oblinger, D. G. (2005). Leading the transition from classrooms to learning spaces. *Educause Quarterly, 1*(7-12). doi: http://www.educause.edu

Peugh, J. L., & Enders, C. K. (2004). Missing data in educational research: A review of reporting practices and suggestions for improvement. *Review of Educational Research, 74*(4), 525-556. doi: http://www.aera.net

Reynard, R. (2009). Designing learning spaces for instruction, not control. *Campus Technology*. http://campustechnology.com/articles/2009/04/29/designing-learning-spaces-for-instruction-not-control.aspx

Richards, C. (2006). Towards an integrated framework for designing effective ICT-supported learning environments: the challenge to better link technology and pedagogy. *Technology, Pedagogy and Education, 15*(2), 239-255. doi: 10.1080/14759390600769771

Romeiser Logan, L., Hickman, R. R., Harris, S. R., & Heriza, C. B. (2008). Single-subject research design: Recommendations for levels of evidence and quality rating. *Developmental Medicine And Child Neurology, 50*(2), 99-103. doi: 10.1111/j.1469-8749.2007.02005.x

Rosen, Y., & Beck-Hill, D. (2012). Intertwining digital content and a one-to-one laptop environment in teaching and learning: Lessons from the time to know program. *Journal of Research on Technology in Education, 44*(3), 225. doi: http://files.eric.ed.gov/

Shadish, W. R., & Cook, T. D. (1999). Comment-design rules: More steps toward a complete theory of quasi-experimentation. *Statistical Science, 14*(3), 294-300. doi: 10.2307/2676764

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston: Houghton Mifflin.

Shear, L., Means, B., Gallagher, L., House, A., & Langworthy, M. (2009). ITL research design. Menlo Park: SRI International.