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## 12. EMERGING EVALUATION KNOWLEDGE IN NEW GENERATION LEARNING ENVIRONMENTS

### INTRODUCTION AND CONTEXT

There is a significant gap in learning environment discourse in connecting graduate attributes to affordances such as space, place, technology and pedagogy. Contemporary journals such as the *International Journal of Learning Environments* rarely include critical articles on aspects of the physical environment of learning communities (Cleveland & Fisher, 2014). Given the limited nature of emergent scholarly, peer reviewed knowledge related to the spatially oriented aspects of learning environments, any attempt to establish an effective research methodology to evaluate the impact of the physical environment on pedagogy and learning outcomes poses a significant challenge.

Wes Imms' earlier chapter draws from a number of past evaluation efforts focused around what are now generally considered as a discredited 'open plan' schools project in the 1970's (Rodwell, 1998). This is followed by a detailed analysis of Hattie's (2008) more recent meta-analysis of open plan schools. Imms concludes that evaluations of learning environments are about more than just design; they must also include teacher pedagogical practice if evaluations are to take into account the interactions between both practice and design. Imms identifies four key issues that must be considered in the context of a quality evaluation: change, design, pedagogy, curriculum and metrics.

But what is it that we are evaluating in new generation learning environments (NGLEs)? The continuing use of the term open plan (Waldrip, Cox, & Jin Yu, 2014) continues to be problematic if considered in the context of NGLEs. Alternative terms such as 'learning landscapes' (Lackney, 2015), technology enabled active learning (or TEAL, see MIT, 1999) and active learning classrooms (Whiteside, Brooks, & Walker, 2010; Walker, Brooks, & Baepler, 2011) denote a more nuanced 'take' on the terrains of learning.

Added to this mix is the concept of 'open programs' that implies curriculum and pedagogical practices can be implemented over these open plans. It appears that the term 'open plan schools' emanated from the 'open education' drive in the 1970s (Rodwell, 1998, p. 103). A new conceptual language is needed, one that reflects the breadth of learning programs that can be carried out in spaces which are capable of morphing rapidly and organically to afford the spatial requirements needed to support a wide range of programs, pedagogical practices and curriculum needs.

Such overarching terms as open plan and open programs diminish the importance and impact of student learning styles (Coffield, Moseley, Hall, & Ecclestone, 2004), the rapid rise of mobile online educational technologies (Churches, 2007) and the cultural pedagogical practice of teachers (NCCREST, 2015). Student learning styles need to be considered within whatever pedagogical practice is being utilised (as illustrated in Figure 1). To this end, perhaps terms such as flexible learning spaces, learning commons, or, better still, agile or adaptive learning spaces, are more reflective of the types of spaces required to support changing pedagogical practices and curriculum needs. Coffield et al.’s model (2004) suggests 13 learning types that have been simplified to four (see Figure 1). Within this framework, for example, can be seen the application by Williams, Armstrong and Malcolm (1985) of the Myers Briggs type indicator to the design of spaces to accommodate a range of personality types.

Whilst the Williams, Armstrong and Malcolm study centred around the design of office spaces, it is worth considering how similar innovative design approaches might be applied to open plan learning environments.

<p><i>Genetic &amp; other constitutionally based factors</i></p> <ul style="list-style-type: none"> <li>• Gregorc’s Mind Styles Model and Style Delineator</li> <li>• The Dunn and Dunn model and instruments of learning styles</li> </ul>
<p><i>The cognitive structure family</i></p> <ul style="list-style-type: none"> <li>• Riding’s model of cognitive style and his Cognitive Styles Analysis (CSA)</li> <li>• The Myers-Briggs Type Indicator (MBTI)</li> <li>• Apter’s reversal theory of motivational styles, the Motivational Style Profile (MSP) and related assessment tools</li> <li>• Jackson’s Learning Styles Profiler (LSP)</li> </ul>
<p><i>Flexibly stable learning preferences</i></p> <ul style="list-style-type: none"> <li>• Kolb’s Learning Style Inventory (LSI)</li> <li>• Honey and Mumford’s Learning Styles Questionnaire (LSQ)</li> <li>• The Herrmann ‘whole brain’ model and the Herrmann Brain Dominance Instrument (HBDI)</li> <li>• Allinson and Hayes’ Cognitive Style Index (CSI)</li> </ul>
<p><i>Learning approaches and strategies</i></p> <ul style="list-style-type: none"> <li>• Entwistle’s Approaches and Study Skills Inventory for Students (ASSIST)</li> <li>• Vermunt’s framework for classifying learning styles and his Inventor Learning Styles (ILS)</li> <li>• Sternberg’s theory of thinking styles and his Thinking Styles Inventory (TSI)</li> </ul>

Figure 1. Learning Styles (after Coffield et al., 2004)

Burke (2005, 2014, & in press) has written on related themes around children and the retreat or ‘cubby-like’ spaces they often chose to occupy. Likewise, Abassi’s

(2010) work examines the types of non-formal spaces utilised by secondary students and the need for secluded, focussed work areas where they can work independently of the wide-ranging program of activities. Indeed office design researchers have now moved on from trying to measure the productivity of workers, and are now focusing on the wellbeing of workers (Steelcase, 2015). Such concepts could be applied to measuring the well-being of both teachers and students in school new generation learning environments, as noted in the Well Certification (2015).

Whilst still an emergent area of focus within learning environments research, the examination of human environment relations has been a significant part of health planning research activities for the past two decades (HERD, 2015). For example a meta-evaluation by Ulrich (2005) has shown that the physical environment has a significant impact on the rate of healing of patients in a wide range of contexts. The education sector needs an equally rigorous approach to measurement and evaluation that might well be rooted in the methodologies used by health planners. These are based in turn on clinical research practice extant in medical research.

Indeed the underlying vision and mission of the Melbourne Graduate School of Education (MGSE, 2015) is premised on clinical teaching, so it is a logical step to look at a clinically informed NGL evaluation models and praxis. The MGSE offers a Masters subject that combines pedagogy and learning spaces and is taught across the two disciplines of education and design by Cleveland and Woodman (2015a). This subject requires master of teaching and master of architecture students to use a research-based methodology to jointly design a ‘real’ space in the educator’s school using evidence of what works as a basis for the proposition. This provides a source of emergent knowledge, although the evidence-base may not be as robust as might be needed to provide substantive ‘proof’ that these innovative practices and designs work because of the short cycle of the course and the associated school prototypes.

Another form of emergent knowledge acquisition which engages teachers and designers in the production of NGL’s is an exercise called ‘Stuff It’, an activity created by Cleveland and Woodman (2015b). This exercise requires teachers and designers to organise the planning of an empty floorplan with spaces, furniture, technologies and zones that support innovative learner centred pedagogies. Such innovations as they exist, however, need to be scaled up to have any significant impact on system-wide embedded cultural teaching practices, many of which remain largely rooted in 20thC practice. Teacher learning – or continuous professional development (CPD) – is patchy in many States of Australia and indeed globally, and is often left up to either the individual teacher or the school to organise. Rarely is such CPD organised around new generation learning environments. However, in some schools, teacher professional development is a significant focus. Bissaker (2010) notes that:

In essence the Australian Science and Mathematics School did not just attend to a transformation of traditional science and mathematics curriculum but addressed many factors at once, including school design, organisational

elements of a school day, pedagogical models, explicit engagement with academics and the role of teachers. In supporting teachers to transition from traditional ways of teaching mathematics and science the school leaders provided a major commitment to the provision of high quality professional learning for all teachers. (p. 3)

#### CASE STUDY: THE AUSTRALIAN SCIENCE & MATHEMATICS SCHOOL (ASMS)

This school opened in 2003 in direct response to the then Australian Chief Scientist (Batterham, 2000) advising that the number of students choosing science and mathematics in secondary schools and universities was diminishing. This was impacting on the country's science and related sectors' capacity to carry out world leading research and was also creating a reduction in the number of science-trained teachers – resulting in a cycle of decline in the quality of science teaching. The school was designed around a problem-based curriculum delivery model that is also a feature of medical training in many Australian Medical Schools. In terms of the spatial implications of these moves, Bissaker, Davies, and Heath (2006) noted:

The design of the building moves away from architectural-pedagogical paradigms that reinforce teacher-centred pedagogical practice and define the traditional power relationship between teacher and student. The design of the building's learning spaces is an architectural response to the desired pedagogical approaches at the school. It is designed for highly collaborative and interactive, student-directed approaches that transfer the power of adolescent social interaction into the learning environment. (p. 2)

The school had a mandate to revolutionise the teaching of science and maths and this, in part, was also necessitated by the emergence of the 'new sciences'. These sciences could not be taught in the traditional single subject mode as they were, and are, cross-disciplinary. They include robotics, photovoltaics, nano technology, space science, aeronautics, biosciences and biomechanics. Further, the traditional one-subject laboratory was not suitable for this cross-disciplinary teaching model. In the first decade of the 2000's, complex world problems were rapidly emerging. These included climate change, water and food security, energy conservation, marine degradation and so on, fields that cross many disciplines of science and also the humanities, social sciences, medicine, engineering, economics and law. Thus we have seen the clustering of research bioscience hubs, technology hubs, manufacturing engineering hubs and more which are all raising the need to train our future researchers and knowledge workers to be cross-disciplinary and highly collaborative in their professional practice.

The single subject teacher-centred pedagogies and learning spaces of the 19th and 20thC were – and are – no longer adequate in the 21stC. The starting point for the ASMS was to rethink the teaching model and shape it in the shadow of these research trends. [Figure 2](#) illustrates the key elements of such a transformative model.

The hierarchical and faculty-focussed model was flattened and formed into teams, working groups, industry impact and relationships (leading to the technology schools network) and teacher learning teams all centred around innovative pedagogy and innovative learning spaces. The framework is focussed on ‘contributive’ leadership with all teachers involved in the planning.



Figure 2. The contributive leadership model at the Australian science and mathematics school (Source: ASMS, 2012)

This team-based integrated approach worked towards a thematically delivered curriculum shaped around a problem-based pedagogy within a spatial framework made up of learning commons and learning studios. All of these elements provided an agile and adaptive framework that could, did, and does transform itself to adapt to new and emerging opportunities. Examples of this include two new aeronautical simulation platforms, a robotics studio capability, and various biosciences specialities (in collaboration with Flinders University). At the time of writing, a three-year experimental InnovSpace has prototyped what will become a ‘maker space’ where students can build scale models to test their new sciences learning on authentic problems in the world (ASMS, 2014). In the latter stages of this ‘proof of concept’ a number of collaborative student projects have been highlighted, including rocket powered cars, the study of graphite and its potential uses and some space sciences studies, with 60% of ASMS students learning how to 3D print. The guiding principles of the maker space are ‘if there is interest, learning happens; making is learning; natural interest in technology; knowhow is infectious; and, create conditions for

learning'. One ASMS industry partner has noted, "they have been the only group of school students who decided to completely design a CubeSats from phase zero. Their initiative is a worldwide first in schools' education and we have been very proud to support them" (ASMS, 2014, p. 24).

The evidence that this school actually works is seen in a number of ways. The students show all visitors around the school, explaining how the spaces work. 90% of students gain access to university programs on graduation. Student testimonies are videoed and are available on the ASMS website. The school is also one of the most visited in Australia, by local, national and international teachers, and by educational administrators, designers and others.



*Figures 3 & 4. ASMS students collaborating on the design of a science and technology-based game and student project on rocket powered cars (Source: ASMS, 2014)*

#### EMERGENT KNOWLEDGE – METHODOLOGY AND METHODS: A REVIEW OF POST 1999 NGL E EVALUATIONS

In seeking to source examples of new and emergent knowledge, Fisher and Newton (2014) evaluated a range of peer reviewed NGL E evaluation studies written in the period 2007–2012. Four that could be considered worthy of consideration of quality scholarly research studies in this field were selected. Subsequently Fisher and Ellis (in press) evaluated additional peer reviewed journal articles published after 2012. They found another four studies worthy of bringing to the attention of researchers. The following sketches some of the key findings of these studies.

By way of a genealogy of learning spaces development (Foucault, 1979), one of the earliest attempts at codifying emergent knowledge in learning environment design was initiated by MIT (1999) in Physics 1 which had very large classes in the programme. It was successfully transferred from the lecture theatre to an active learning classroom model. Subsequently, Sanoff (2001) developed a school building environment ratings survey instrument based around the Likert scale. While no significant comparative results appear to be available, the tool is a robust attempt at developing emergent knowledge of school design alternatives. Later there was an increase in interest around NGL E's initiated by Educause (Oblinger, 2006) and JISC

(2010). Both agencies had previously engaged largely in ICT and learning, but were finding that the spatial dimension remained unchanged whilst technology evolved at a rapid rate alongside these largely static 20thC learning environments.

In the USA, Whiteside, Brooks, and Walker (2010), explored a ‘before and after’ scenario by comparing a traditional teacher-centred classroom with an NGLE space.



*Figures 5 & 6. Industrial age ‘before’ and NGLE ‘after’ classrooms  
(Source: Whiteside et al., 2010)*

They surveyed 13 groups of 9 students in a TEAL (technology enhanced active learning) space and found that there were clear increases in student grades – compared with the traditional classrooms – of 7%. At the same time, key activities in the active classroom included increased group activity, a higher level of engagement between individual students and the teacher, and less teacher centred direct instruction.

Yet another study (Barrett, Zhang, Moffat, & Kobbacy, 2013) focussed in particular on indoor environment quality (IEQ) and its influence on primary school learning outcomes. An environment-human-performance (EHP) model was developed and incorporated within ten design characteristics framed around three design principles (refer to [Figure 7](#)): *naturalness* (light, sound, temperature and air quality); *individualisation* (choice, flexibility, connection); and *stimulus* (complexity, colour and texture). Of these ten, six were found to have a high influence – i.e. colour, choice, connection, complexity, flexibility and light. Seven primary schools were selected in the UK with 751 pupils occupying 34 classrooms. Tested over one year, the model concluded that the environment did affect students’ learning outcomes and, through a multivariate analysis, it was estimated it had an influencing factor of 25%. The study ‘nested’ the results as Level 1 pupil factors (which had high individual variance due to student demographic backgrounds), with the Level 2 class factors having a much lower variance (73% reliability) as they were related to the six school design parameters. Barrett et al. (2012) also acknowledged that there was no measure for teacher effects that could influence the results significantly. This writer finds this a major flaw in this study. However, the process is useful in terms of the attempt to coordinate the three key characteristics of naturalness, individualisation and stimulus, which can inform NGLE design processes.

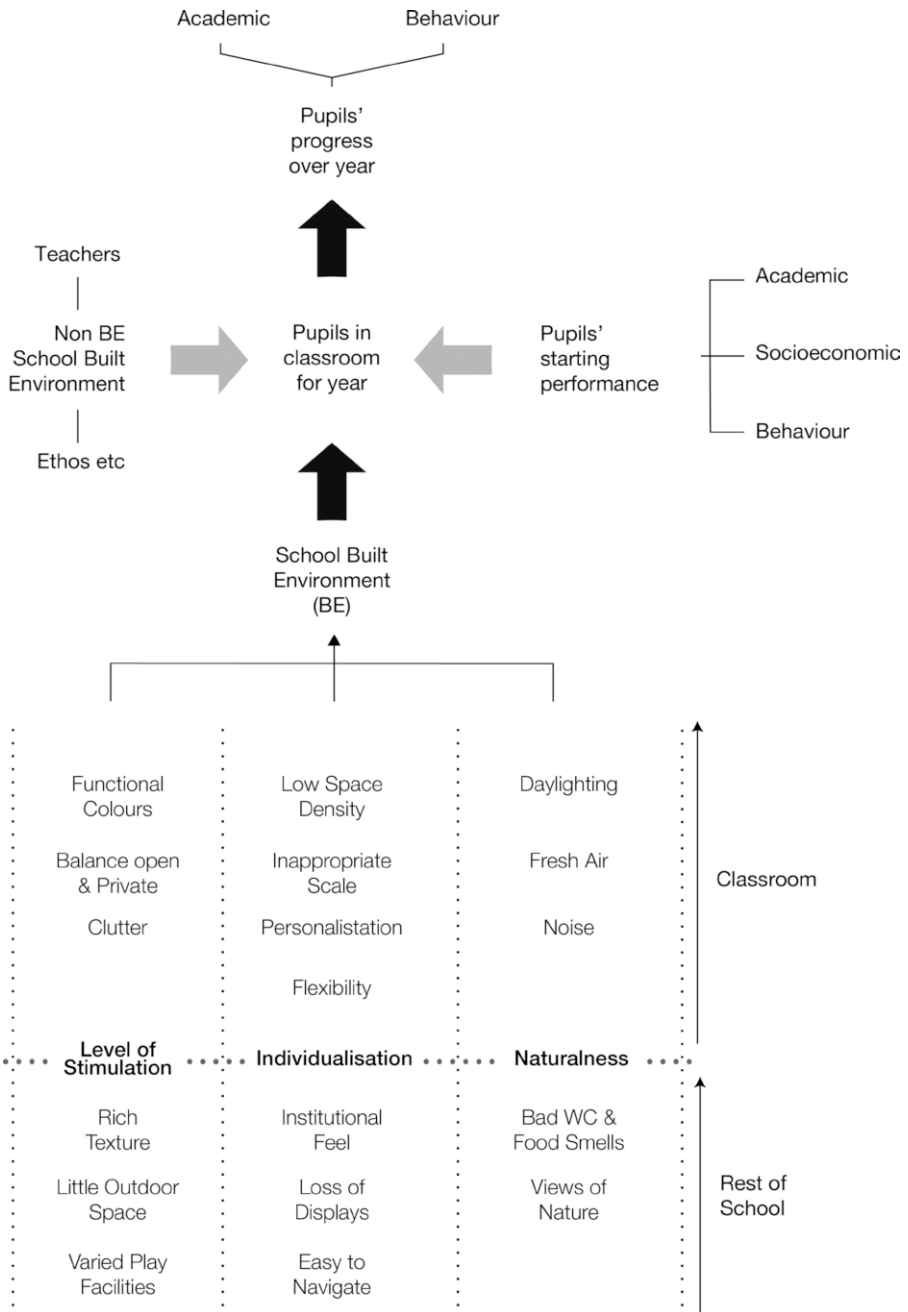


Figure 7. Diagram of research design parameters (Source: Barrett et al., 2012)



A study at university level by Brooks (2012) examined 55 key learning activity factors with 5-minute observational reviews of what was happening in the active learning space. This was supported by subsequent student survey questionnaires, interviews and focus groups to cross-reference and triangulate the findings. Brooks used four variable clusters: activities, modes of instruction, teacher behaviours, and student behaviours. This is the most significant survey seen thus far by this writer and is a model for future studies. Brooks (2012) notes that “in general terms, we have provided empirical evidence of a causal relationship that can be stated best in syllogistic terms: (1) space shapes instructor behaviour and classroom activities; (2) instructor behaviour and classroom activities shape on-task student behaviour; therefore, (3) space shapes on-task student behaviour” (p. 10).

Two years later, Prain, Deed, Edwards, Farrelly, Keeffe, Lovejoy, Mow, Waldrip, and Yager (2014) combined a range of factors impacting on school design as illustrated in Figure 8. This study examined the complexity of a regeneration project that witnessed schools’ return to a modified ‘open plan’ – preferably redefined (see earlier discussion) as a contemporary blended-learning environment. Three schools were tracked from their original traditional classrooms practice from 2008 to their new site in 2012 with the results showing clear increases in numeracy and literacy. These were measured using Naplan tests and these results showed how the schools had moved up the rankings. The complexity surrounding the transformation from a teacher-centred classroom model to a learner centred learning neighbourhood model was illustrated in this study.

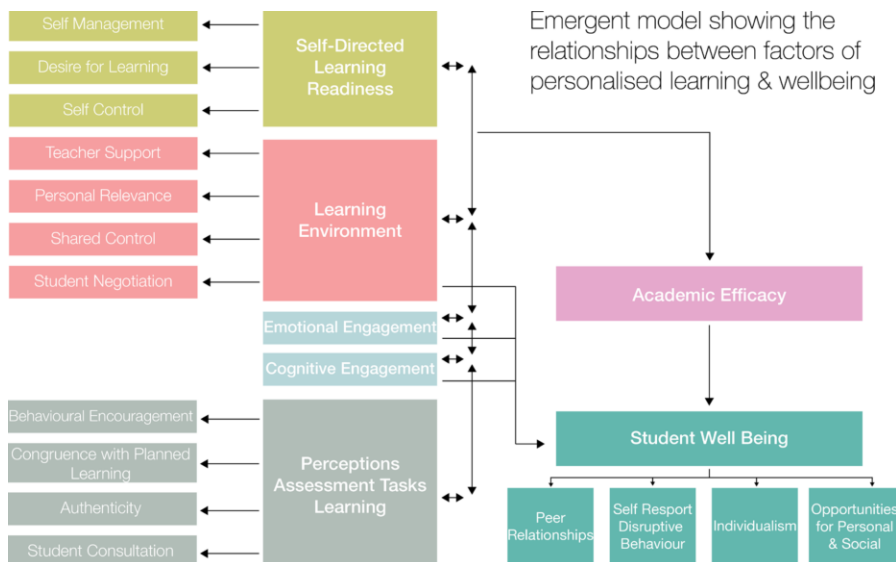


Figure 8. Factors impacting on the design and evaluation of an NGL  
(adapted from Prain et al., 2014)

In 2014 Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt, and Wenderoth when exploring science, technology, engineering and mathematics (STEM) learning environments, argued that there was evidence demonstrating that the lecture mode of curriculum delivery was providing diminishing learning outcomes. If the teaching of science was to be based on evidence – which is the fundamental basis for the epistemology of science – then shouldn't STEM teaching be looking at alternatives to the lecture mode of delivery? They evaluated 225 published and unpublished evidence-based articles on teaching STEM in NGLÉ's where

the active learning interventions varied widely in intensity and implementation, and included approaches as diverse as occasional group problem-solving, worksheets or tutorials completed during class, use of personal response systems with or without peer instruction, and studio or workshop course designs. (p. 1)

They found that students were 50% more likely to fail if attending a lecture-based programme than if they attended an active learning based programme.

In another study Baepler, Walker and Driessen (2014) investigated where lectures were delivered online with students having 1/3rd less staff contact time. They engaged with the material with peers and teachers in an active classroom, and in effect the process modelled the emerging flipped classroom approach. They found that:

[in] an active learning classroom, student faculty contact could be reduced by two-thirds and students achieved learning outcomes that were at least as good and, in one comparison, significantly better than those in a traditional classroom. Concurrently, student perceptions of the learning environment were improved. (p. 227)

Another largely quantitative study by Scott-Webber, Strickland and Kapitula (2013) used measures of student engagement (National Survey of Student Engagement, 2011) in three different active classroom layouts (ACL) compared against a fourth traditional all-seats-facing-the-front model. Whilst Jankowska and Atlay (2008) have shown that student engagement links to learning outcomes, the authors used brain science (Jensen, 2005) and brain-compatible classrooms (Erlauer, 2003) as additional sources of supporting evidence regarding the impact of an active learning engagement. Thus four aspects were measured – behavioural, psychological, socio-cultural and holistic. In noting that there are many other possible variables, the authors stated that:

However, in attempting to establish a relationship between the designed environment and the behavioural factors of student engagement, it is important to develop a body of evidence that establishes a foundation for the idea that the learning environment impacts student behaviours. (Scott-Webber, Strickland, & Kapitula, 2013, p. 2)

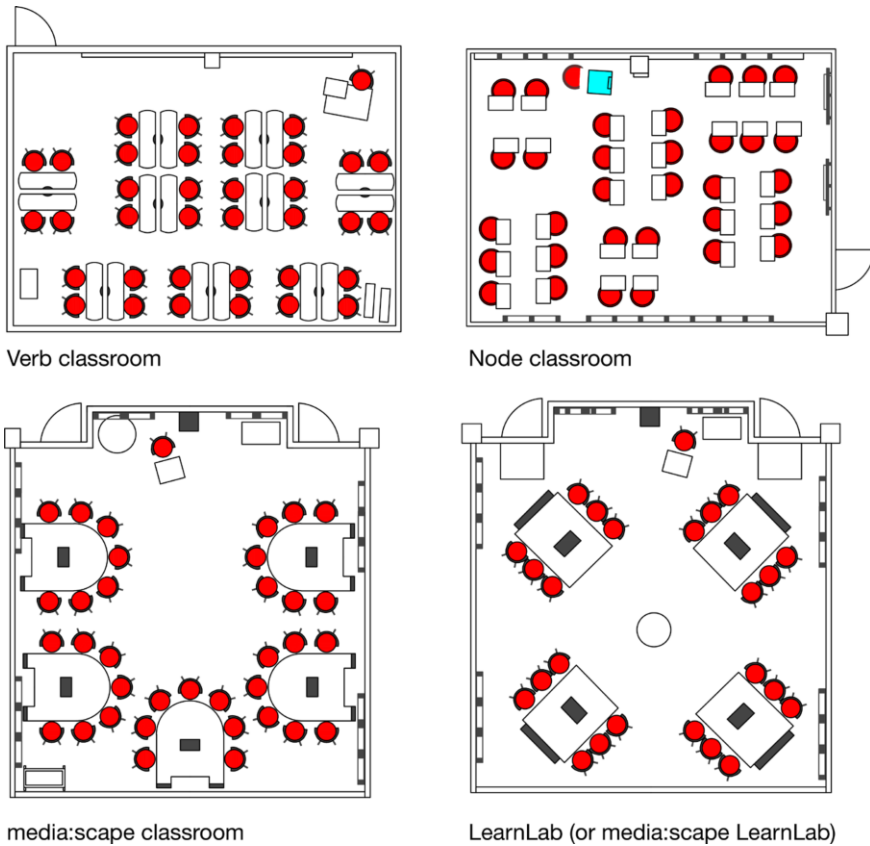


Figure 9. Steelcase 'Solutions' for four typologies (Source: Scott Webber et al., 2013)

There were three parts in the Scott-Webber et al. project (2013). Firstly, the demographics and baseline were established – i.e. the educational level of the student, type of course, type of ACL instructional approach and perceived level of engagement. Secondly, learning practices and solutions were evaluated using 12 identified student engagement factors which included collaboration, focus, active involvement, opportunity to engage, repeated exposure to material through multiple means, in-class feedback, real-life scenarios, ability to engage ways of learning best, physical movement, stimulation, feeling comfortable to participate, and the creation of an enriching experience. The learning practices were replicated in the three ACL's and the fourth traditional space to measure the extent of student engagement. The final stage was a 'perception of outcomes' questionnaire in which students responded re the 'old' and the 'new' to levels of engagement in class, grade achievement, motivation to attend plus an open-ended comments.

Validation of the results was through an established psychological testing process. Over 90% of students found the three ACL prototypes:

provided adequate or better engagement and support of classroom practices. Most rated the engagement factors higher or better than the traditional. Teaching practices scored 36.3 out of 48 in the ACL, and 21.6 in the traditional. 80% rated a better ability in achieving a higher grade in the ACL's, and 78% had increased motivation. (Scott-Webber, Strickland & Kapitula, 2013, p. 6)

These findings correlated with teacher perceptions. Although the researchers noted some limitations in the study, they believed that this evidence-based evaluation was valid and that such research methods should be precursors to all new NGLÉ's and that the environment does impact on student behaviour.

A newly released book looking at school design through architectural psychology (Walden, 2015) sets out what is effectively a checklist for school design. However, it does not seem to take an evidence-based approach to its work. That said, it is worth highlighting what it notes about the design of schools:

Our real illiteracy is not the ignorance to read and write and not the incapability to repeat other people's knowledge, but the inability to create. A child possesses this creative ability; the seemingly illiterate seemingly ignorant child is not ignorant and not illiterate at all. On the contrary it (sic) is in full possession of his (sic) own creative powers .... (Hundertwasser as cited in Walden, 2015)

Hundertwasser was most likely the instigator of contemporary biophilic design, much of which does have an evidence-base drawn from health planning environmental design research mentioned earlier in this chapter.

#### EMERGING KNOWLEDGE IN LEARNING ENVIRONMENT EVALUATION

The three following chapters in this section on emergent knowledge epitomise the efforts now taking place to further develop the scholarly evidence-based literature on new generation learning spaces.

Barry and Raftery examine the built forms supporting the new Junior Cycle in Irish schools (JCSA) and find them wanting. They argue that the over-proscriptive space planning and furniture design guidelines of the Governing Department need to be reviewed to enable a much more relevant learning environment design in support of the new JCSA pedagogy and curriculum innovations. These new designs should also be supported by extensive teacher professional development in new generation learning environments (including online), and that teachers should be involved, along with students, in the design of new primary schools. The existing rigid and proscriptive space planning guidelines do not allow for future changes in pedagogy and curriculum

Soccio focuses on the technical performance of the learning environment. Research has consistently shown that poor acoustics, temperature control, artificial

and natural lighting, air flow and materials selection all impact on the wellbeing of staff and students Ulrich, Quan, Zimring, Joseph and Choudhary, 2005). Soccio's studies are replicated across many schools in Victoria with very telling results. Indeed, we must make sure that the environmentally sustainable design features installed in schools are not redacted through teachers resisting the move towards NGLÉ's by closing up their new energy efficient designs and people efficient spaces as has occurred in too many schools to date.

Dane has developed a learning environments evaluation model that takes account of technical features, information technologies, educational technologies, furniture, pedagogical affordances and other factors. This 'tool' is in the process of being rolled out on a range of learning spaces and will provide outputs that can be comparable in terms of the various elements being measured. It will enable a deeper analysis and understanding of what works and why, and importantly what is needed to update the existing 20thC learning environments estate we must deal with.

These three Chapters are just a Snapshot of what is currently being undertaken in terms of qualitatively based evaluation methods at the University of Melbourne. They contribute to emerging knowledge on the scholarly evaluation of new generation learning environments research and will help to inform new designs, new teacher practices and supplement – in a timely way – the emergent knowledge base in NGLÉ's as the school estate is brought up to contemporary standards at a very significant cost. We should have appropriate knowledge on which to base these designs so the investment is not wasted on new 21stC replicas of 20thC schools which are increasingly being proven by researchers to be inadequate for today's learners.

## REFERENCES

- Abassi, N. (2010, May). *The role of multi-purpose learning spaces in supporting 21st century curriculum*, Mayfield Project. CEFPI Annual Regional Conference on Designing for Difference, Perth.
- ASMS. (2014). *InnovSpace: A three-year experiment in maker spaces. Report*. Adelaide: ASMS. Retrieved September 23, 2015, from <https://www.asms.sa.edu.au/wp-content/uploads/2015/01/InnovSpace.pdf>
- ASMS. (2012). *Sustaining innovation through contributive leadership*. Adelaide: ASMS. Retrieved from <https://www.asms.sa.edu.au/wp-content/uploads/2012/10/ASMS-innovation-AARE-dec12.pdf>
- Baepler, P., Walker, J., & Driessen, M. (2014). It's not about seat time: Blending, flipping, and efficiency in active learning classrooms. *Computers & Education*, 78, 227–236. doi:10.1016/j.compedu.2014.06.006
- Barrett, P., 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, 678–689. doi:10.1016/j.buildenv.2012.09.016
- Batterham, R. (2000). *The chance to change: Final report*. Canberra: Department of Science, Industry and Resources.
- Bissaker, K. (2010). *The processes and outcomes of professional learning in an innovative school: The construction of an explanatory model* (Unpublished thesis). Retrieved June 1, 2014, from <http://catalogue.flinders.edu.au/local/adt/public/adt-SFU20100309.162227/n>
- Bissaker, K., Davies, J., & Heath, J. (2006, May 25–27). *Re-thinking schooling: Reflections from the Australian science and mathematics school*. Educational Research Association of Singapore (ERAS), Singapore.

- Brooks, C. (2012). Space and consequences: The impact of different formal learning spaces on instructor and student behavior. *Journal of Learning Spaces*, (2).
- Burke, C. (Ed.). (2005). *Containing the school child: Architecture and pedagogies*. Double special issue of the *Journal Paedagogica Historica*. Abingdon: Taylor & Francis.
- Burke, C. (2016, June). Quiet stories of educational design. In K. Darian-Smith & J. Willis (Eds.), *Designing schools: Space, place and pedagogy*. London: Routledge (Architecture).
- Burke, C. E., Grosvenor, I. E., Norlin, B. E., & Umeå universitet, H. O. (2014). Engaging with educational space: Visualizing spaces of teaching and learning. *Umeå Studies In History And Education*.
- Churches, A. (2007). *Bloom's digital taxonomy*. Retrieved from <http://edorigami.wikispaces.com>
- Cleveland, B., & Fisher, K. (2014). The evaluation of physical learning environments: A critical review of the literature. *International Journal of Learning Environments*, 17, 1–28. (Sense Publishers.)
- Cleveland, B., & Woodman, K. (2015a). *Innovative spaces and pedagogy: Master of teaching subject*. Parkville: Melbourne Graduate School of Education.
- Cleveland, B., & Woodman, K. (2015b). *Stuff it*. Retrieved from CEFPI website: [www.cefpi.com](http://www.cefpi.com)
- Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning styles and pedagogy in post-16 learning: A systematic and critical review. *Learning & Skills Research Centre*. Retrieved from <http://www.leerbeleving.nl/wp-content/uploads/2011/09/>
- Erlauer, L. (2003). *The Brain-compatible classroom [electronic resource]: Using what we know about learning to improve teaching*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Fisher, K., & Ellis, R. (in press). *A critical review of post 2012 literature on the evaluation/evidence-based design of new generation learning environments*.
- Fisher, K., & Newton, C. (2014). Transforming the twenty-first-century campus to enhance the net-generation student learning experience: Using evidence-based design to determine what works and why in virtual/physical teaching spaces. *Higher Education Research and Development*, 33(5), 903–920.
- Foucault, M. (1979). *Discipline and punish: The birth of the prison*. Harmondsworth: Penguin.
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of The National Academy of Sciences of the United States*, 111(23), 8410–8415. doi:10.1073/pnas.1319030111
- Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. London & New York, NY: Routledge.
- HERD. (2015). *Health environments research journal*. Retrieved from <http://her.sagepub.com>
- Jankowska, M., & Atlay, M. (2008). Use of creative space in enhancing students' engagement. *Innovations In Education & Teaching International*, 45(3), 271–279. doi:10.1080/14703290802176162
- Jensen, E. (2005). *Teaching with the brain in mind* (2nd ed., rev., updated ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- JISC. (2010). *Joint information services committee*. Retrieved September 23, 2015, from <http://www.webarchive.org.uk/wayback/archive/20140614151101/http://www.jisc.ac.uk/whatwedo/programmes/elearninginnovation/learningspaces.aspx>
- Lackney, J. A. (2015). History of the schoolhouse in the USA. In R. Walden (Ed.), *Schools for the future: Design proposals from architectural psychology*. Koblenz, Germany: Springer.
- MGSE. (2015). *Clinical teaching*. Retrieved from [http://education.unimelb.edu.au/about\\_us/clinical\\_teaching](http://education.unimelb.edu.au/about_us/clinical_teaching)
- MIT. (1999). *TEAL: Technology-enhanced active learning*. Retrieved from <http://web.mit.edu/edtech/casestudies/teal.html>
- National Survey of Student Engagement (NSSE). (2011). *Fostering student engagement campuswide – Annual results 2011*. Bloomington, IN: Indiana University Centre for Postsecondary Research.
- NCCREST. (2015). *National centre for culturally responsive educational systems*. Retrieved from <http://cobbesol.org/ESOL/index.php/professional-learning/62-professional-learning/esol-endorsement/cultural-issues/316-national-center-for-culturally-responsive-educational-systems-nccrest>.

- Oblinger, D. (2006). Learning spaces. *EDUCAUSE*. Retrieved from <http://www.educause.edu/research-and-publications/books/learning-spaces>
- Prain, V., Cox, P., Deed, C., Edwards, D., Farrelly, C., Keeffe, M., Lovejoy, V., Mow, L., Waldrip, B., & Yager, Z. (Eds.). (2014). *Adapting to teaching and learning in open-plan schools*. Rotterdam, The Netherlands: Sense Publishers.
- Rodwell, G. (1998). Open-plan school architecture: A continuation of a tradition of bureaucratically imposed innovation in Australian State Schools. *Education Research and Perspectives*, 25(2), 99–119.
- Sanoff, H. (2001). *School building assessment methods*. Washington, DC: National Clearinghouse for Educational Facilities.
- Scott-Webber, L., Strickland, A., & Kapitula, L. R. (2013). Built environments impact behaviors: Results of an active learning post-occupancy evaluation. *Planning for Higher Education*, (1), 28.
- Steelcase. (2015). An arizona state study: Movement in the workplace. *360 Magazine*, November 11(67). Retrieved from <https://www.steelcase.com/insights/articles/an-arizona-state-study-movement-in-the-workplace/>
- Ulrich, R., Quan, X., Zimring, C., Joseph, A., & Choudhary, R. (2005, May). Abstract supplement to a report to The Center for Health DesignSM for the Designing the 21st Century Hospital Project. *The Center for Health DesignSM*.
- Walden, R. (Ed.). (2015). *Schools for the future: Design proposals from architectural psychology*. Rotterdam, The Netherlands: Sense Publishers.
- Waldrip, P., Cox, P., & Jin Yu, J. (2014). Quantitative research on personalising learning and wellbeing in open-plan up-scaled learning communities. In V. Prain, P. Cox, C. Deed, D. Edwards, C. Farrelly, M. Keeffe, V. Lovejoy, L. Mow, P. Sellings, B. Waldrip, & Z. Yager. (Eds.), *Adapting to teaching and learning in open-plan schools*. Rotterdam, The Netherlands: Sense Publishers.
- Walker, J. D., Brooks, D. C., & Baepler, P. (2011). Pedagogy and space: Empirical research on new learning environments. *EDUCAUSE Quarterly*, 34(4), 1.
- Well Certification. (2015). *Well building standard: Educational facilities pilot Addendum*. Retrieved from <http://www.wellcertified.com/articles/international-well-building-institute-launches-pilot-programs-new-market-sectors>
- Whiteside, A. L., Brooks, D. C., & Walker, J. D. (2010). Making the case for space: Three years of empirical research on learning environments. *EDUCAUSE Quarterly*, 33(3).
- Williams, C., Armstrong, D., & Malcolm, C. (1985). *The negotiable environment: People, White collar work and the office*. Ann Arbor, MI: Facility Management Institute.

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