Learning Environments and New Spaces Literature review.

Associate Professor Kym Fraser, RMIT University
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Introduction

The Learning Environments and New Spaces (LENS) Research Network supports RMIT University staff to conduct pedagogic research in new learning spaces (NLSs). RMIT University continues to invest significantly in the building of NLSs that are technologically enabled and designed to promote active, collaborative and peer-based approaches to learning (Brown, 2005; Oblinger, 2005; JISC, 2006; Steel and Andrews, 2012). Given this investment, it is imperative to explore how these environments can be used to capitalise on new pedagogies, digital technologies and sustainable learning designs.

The purpose of this review is to support the pedagogic research that will be the focus of the LENS network. As such the review focuses on identifying:

- gaps in the research;
- frameworks and models to improve L&T research in new learning spaces in the RMIT University context;
- literature in specific NLS curriculum areas; and
- potential partners with whom to conduct research.

The review is structured in terms of four key areas in the new learning space literature: facilitating learning; the design of learning spaces; the evaluation of learning spaces; and pedagogical research. The Radcliffe et al. (2008) Pedagogy/Space/Technology framework is used to frame the last section of the review, which focuses on the implications of the review for potential areas of new learning space research at RMIT University.

The literature review is written in conjunction with an bibliography of the literature. As of June 2013, the annotated bibliography includes the review of over 100 articles, book chapters and reports. The annotated bibliography builds upon and includes much of the annotated bibliography of the Australian Learning and Teaching Council funded 'Evaluation of Learning Spaces' (Lee et al., 2011).

Facilitating learning in NLSs

By beginning the NLS literature review with a focus on effective adult learning/teaching, I seek to keep upper most in our minds the student outcomes that we wish to achieve through our work in NLSs. Since Chickering and Gamsons' development of '7 Principles of good practice in undergraduate education' in 1987, several researchers have developed lists of principles for effective teaching/effective learning in higher education (Radloff, 2012; Ramsden, 2003; Van Note Chism, 2002). Please refer to Appendix 1 for a summary of some of this work. Principles such as learning is active, connected, interactive/social, reflective and applied (Radloff, 2012), have implications for the design of NLSs in areas such as the type and arrangement of furniture, the acoustics of the space, the technology used and its access, as well as the type of spaces developed (Radcliffe et al, 2008).

Van Note Chism (2002) was one of the first researchers to link learning principles with learning space design. Using the American Association of Higher Education 'Principles and Collaborative Action' (1998) (refer to Appendix 1), she argued that to facilitate connected, active learning in a social context, we need to develop a range of spaces (also identified as a 'desperate' need by Souter et. al., 2011):

- where small groups could meet to work on projects;
- for whole-class dialogue;
- where technology can be accessed easily;
- for displaying ideas and working documents;
- that can accommodate movement and noise; and

- include spill over spaces in corridors and lobbies (Van Note Chism, 2002).

While authors argue that a more student centred learning approach to teaching has inspired the design of NLSs (Tom et. al., 2008), and that changed spaces change practice (JISC, 2006), Lee and Tan (2011) note that there is little evidence that changes in spaces effect long-term change in practice saying that in the literature to date (2011), "…there are no details regarding the interaction of space and teaching practice, curriculum and students" (Ibid. 12). They go on to say that the sector needs to engage in long term evaluations to determine if a changed space changes teaching practices, perspectives and activities.

Design of learning spaces

Arguably the learning space literature first appeared at the turn of the century and since that time, the vast majority of that literature has been devoted to the design and evaluation of spaces. In the main, this literature identifies strategies, models, approaches, rules, steps, frameworks and principles to underpin the design of spaces. There is much debate in the learning space design literature as to which design principles best underpin the development of new learning spaces and that debate depends in part, on what the spaces are being designed to achieve (Brown and Lippincott 2003; JISC, 2006; Johnson and Lomas 2005; Long and Ehrmann 2005; Milne, 2006; Oblinger, 2005). Radcliffe et al. (2008), is perhaps the most inclusive when suggesting that the factors that underpin experimentation in the design of learning spaces include a shift to more learner centred pedagogy, new technologies, generational change, and changes in social patterns and finances.

Very few researchers in this area use a framework to develop their lists/guiding principles and very little of the research shows explicitly how the principles identified relate to the pedagogic principles and activities that the authors are trying to achieve. Arguably the work is at best, not constructively aligned (Biggs, 1996) and at worst, atheoretical.

Broadly the literature (refer to Appendix 2) suggests that when designing a learning space, the university needs to:

1) follow a set of **rules** (Johnson and Lomas, 2005; Souter et. al., 2011); and
2) underpin the development with design **principles** of (Johnson and Lomas, 2005; Oblinger, 2006; Mitchell et. al., 2010; et al.; 2008).

Rules

The following rules or steps that institutions need to take when designing NLSs are drawn from the literature.

1) Identify the institutional context (Johnson and Lomas, 2005)
2) Specify learning principles meaningful to that context (Johnson and Lomas, 2005; Radcliffe et al., 2008)
3) Define the learning activities that support these principles (Johnson and Lomas, 2005; Radcliffe et al., 2008)
4) Develop clearly articulated design principles (Johnson and Lomas, 2005; Mitchell et. al. 2010; Radcliffe et al., 2008)
5) Create a set of requirements (Johnson and Lomas, 2005)
6) Determine a methodology for evaluating the space from pre- design through to post occupation (Lee and Tan, 2011)
7) Identify reliable data about how the space will be used (McFarlane and Bailey, 2006)
8) Consult with a wide range of stakeholders including administrative staff, academics, students (undergrad and postgrad), facilities, planning, information technology, library and teaching and learning support (Lee and Tan, 2011; Oblinger, 2005; Radcliffe et al., 2008; Souter et. al. 2011)
9) Determine what tensions arise from differing needs of those who will use the space (Lee and Tan, 2011)
10) Consult with external colleagues who have developed and evaluated spaces (Souter et. al., 2011)
11) Withhold 15% of building budget to modify and adjust spaces after construction (Souter et al, 2011)

12) Foster the crucial elements of informal learning such as: comfortable seating; protection from weather; access to power; Wi-Fi; extended hours of access; access to food; lockers; and reconfigurable spaces, including lighting and furnishings (Souter et. al., 2011)
13) Support students' own technologies and technological preferences (Souter et. al., 2011)
14) Develop 'sandpit' or experimental spaces to develop and test prototypes (Souter et. al., 2011)

Design Principles

Step 4 in the 'Rules' above requires the development of a clearly articulated set of design principles to guide the project. Many of the authors cited in the 'Rules' section articulate a set of design principles, while not necessarily referring to them by that name. In this review I have chosen to report the design principles articulated in the ALTC funded project 'Retrofitting University Spaces' (Mitchell et. al., 2010) as this was the most rigorous of the research reviewed in this area. This project team developed their principles based on the work of earlier authors. They also articulated a clear framework for developing the principles, and uniquely, that framework included not only a pedagogic basis but also a product design basis. This work adds a rigour and internal consistency to their principles that was lacking in the design principles espoused by previous research. Their principles also appeared to incorporate virtually all of the principles articulated by previous research.

Mitchell et. al. (2010) underpinned their design principles framework with the question driven Pedagogy/Space/Technology (PST) framework illustrated in Table 1 (Radcliffe et. al., 2008).

Table 1. Question* driven Pedagogy-Space-Technology Framework for developing learning spaces (Radcliffe et. al. 2008: 3).

	Life Cycle Stage	
Focus	Conception and Design	Implementation and Operation
Overall	What is the motivation for the initiative?	What does success look like?
Pedagogy	What type(s) of learning and teaching are we trying to foster and why?	What type(s) of learning and teaching are observed taking place? What is the evidence?
Space	What aspects of the design of the space and provisioning of furniture and fittings will foster these models of learning and (teaching)?	Which aspects of the space design and equipment worked and which did not? Why?
Technology	How will technology be deployed to complement the space design in fostering the desired learning and teaching patterns?	What technologies were most effective at enhancing learning and teaching? Why?

* The project report provides an expanded set of detailed questions that can be asked.

Mitchell et al. (2010) used the PST framework to develop their guidelines for retrofitting learning spaces from each of the three PST perspectives. The authors then collated the guidelines, removing duplication between the three PST perspectives, and identified 25 design guidelines for new learning spaces. From there the authors further analysed the guidelines from the perspective of key stakeholders (students, teachers and support staff) and overlayed the PST framework with a modified LUCID framework (Kreitzberg 2008) that comes from the field of product design. The LUCID framework includes engagement, empowerment, ease of use and trust as the key elements in the design of interactive products. This analysis of the 25 guidelines from the perspectives of the two frameworks led to the collapsing of the 25 guidelines to produce 8 principles to guide the design of spaces. Next to each principle in Table 2, I have indicated other authors whose work supports the essence of the principle.

Table 2. Design Principles that underpin the design of learning spaces (adapted from Mitchell et. al. 2010, p.1). (References at the end of each Principle have been added to indicate other authors who have discussed these principles).

	Principles
Engagement	Principle 1: Spaces should support a range of learners and learning activities

	(Punie, 2007; Radcliffe et al., 2008; Souter, 2011).
	Principle 2: Spaces should provide a quality experience for users (Souter, 2011).
Empowerment	Principle 3: Spaces should help foster a sense of emotional and cultural safety (Punie, 2007; Souter, 2011).
	Principle 4: Spaces should enable easy access by everyone (Souter, 2011).
Ease of Use	Principle 5: Spaces should emphasize simplicity of design (Radcliffe et al., 2008).
	Principle 6: Spaces should integrate seamlessly with other physical and virtual spaces (Skill and Young, 2002; Souter, 2011).
Confidence	Principle 7: Space should be fit-for-purpose, now and into the future (Punie, 2007).
	Principle 8: Spaces should embed a range of appropriate, reliable and effective technologies (Punie, 2007; Radcliffe et al., 2008).

Another aspect that I would add to Principle 5 is that spaces need to be adaptable/flexible to provide for 'future proofing' (JISC, 2006; Skill and Young, 2002; Souter et al, 2011).

The evaluation of learning spaces

As indicated above, most of the new learning space literature focuses on the design and evaluation of spaces. In 2009 the Australian Learning and Teaching Council funded the project 'Evaluating Learning Spaces' to review the evaluation of spaces. This section relies primarily on their findings.

Lee et. al. (2011) identified approximately 100 articles, reports, presentations and books that focussed on the design and evaluation of learning spaces. Through their review of this literature they made the following comments:

- "In general, these articles appeared to stress the need for more flexible, technology embedded, student-centred spaces (Lee et. al. 2011, p. 3).
- There is "…little empirical evidence on the evaluation of learning spaces". (Lee et. al. 2011, p. 3)
- Some researchers "claim that having student-centred learning spaces will improve student learning outcomes (Weaver, 2006; Milne 2007). However, the articles reflected little empirical evidence to support their claims (Woolner et al 2007)". (Lee et. al. 2011, p. 3)
- It is important to conduct pre-design evaluations as well as post occupancy evaluations to guide learning space design, encourage "…accountability among stakeholders, encourage end-user input to lessen the risks of unwanted problems, and provide feedback for future developments and improvements" (Lee et. al. 2011, p. 3; Radcliffe et al., 2008; Leonard, 2007; Brown and Lippincott, 2003; Van Note Chism and Bickford, 2002; and Harper et. al. 2002).
- It is important to involve the range of stakeholders in the evaluation for the design of spaces in order to incorporate pedagogic needs into the design (Oertel, 2005; Dittoe, 2007; Lee, 2007; Woolner et al. 2007a; Woolner et al. 2007b; Lee et. al. 2011). It is important to realise that different stakeholders may hold conflicting interests.
- Institutions typically don't fund evaluations as part of their funding for the design of spaces (Lee and Tan, 2011).
- The acoustics of learning spaces is an ongoing problem in spaces where collaborative learning is fostered, in particular with large groups. (Lee and Tan, 2011).
- There is a "… lack of longitudinal and comparative research regarding the impact of campus design on learning and teaching practice". (Lee and Tan, 2011, p.2).
- The sector needs to find proxies for student learning outcomes in order to evaluate the impact of the design of spaces on student outcomes (Lee and Tan, 2011, p.2).

The basic message that we can take away from this list of concerns is that when designing spaces, we need to intentionally fund a range of evaluative strategies that involve stakeholders. We also need to use purposeful evaluation to underpin any claims that we wish to make about the impact of the spaces on student outcomes and teaching practices.

Lee and Tan (2011) identified the need for, and developed (Figure 1), a 'baseline development model' to underpin evaluation approaches for the design of learning spaces. The underpinning model allowed for different evaluation approaches to be used to cater for different contexts. They used this framework to underpin several quite different space design evaluations in their project.

In the baseline development model Lee and Tan (2011) identified "…three interconnected stages of design, build and occupy, during which particular concerns were likely to be addressed by evaluation. This cycle presupposes a process of evaluation that is similar to that of the action- research cycle. Specifically, that each round of evaluation should inform subsequent stages, and subsequent projects, while taking into account drivers questions and contextual factors. Alongside this cycle, dimensions of stakeholders and needs were to be investigated" (Ibid. pp. 4 – 5).

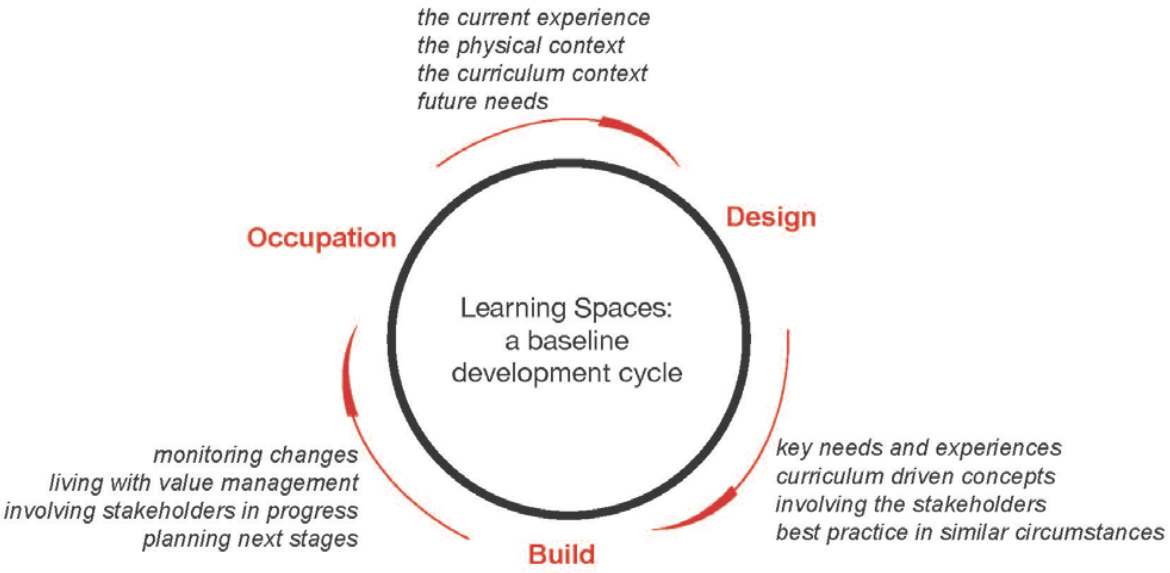

Figure 1: the baseline development model

Figure 1. The 'Evaluating Learning Spaces' baseline development model (Lee and Tan, 2011, p 5).

The Evaluating Learning Spaces project also produced a web based 'toolbox' of evaluation strategies that have been used at universities in Australia and overseas (http://www.swinburne.edu.au/spl/learningspacesproject/database/index.html). While many of the evaluation strategies used are relatively traditional (frequency of use, student and teacher satisfaction surveys, focus groups, interviews), non traditional approaches are also captured, for example "Milne (2006) suggests using photo surveys with journal entries and surrogate student profiles to elicit brainstorming among stakeholders during workshop sessions". (Lee et. al., 2011, p. 3).

Lee and Tan (2011) concluded that: there isn't an effective 'one size fits all' approach to learning space design; there is "…significant value in providing spaces that are dedicated to particular cohorts (Ibid. p. 13) "; there is a need for support in order for lecturers to change their teaching practices; and the design of courses needs to take into account that students come to the spaces with different expectations and skill sets.

Pedagogy

A search of relevant databases (e.g. ERIC) found very little research about pedagogy in new learning spaces in **tertiary** settings. The dominant tertiary literature is about the design and the evaluation of spaces.

Oblinger (2005) was one of the first researchers to connect the design of teaching spaces with pedagogic practice. The basic argument is that new learning spaces should foster high levels of student-to-student and student-to-staff contact to create opportunities for active and collaborative learning (George et al., 2009). While authors argue that the new spaces should lead to improved student outcomes (Milne, 2007; Weaver 2006) there is little literature showing the impact of new spaces on teaching practice and learning outcomes.

The most well known pedagogical research in tertiary new learning spaces comes out of the SCALE UP project from North Carolina State University (Beichner et al, 2007) and the TEAL project from Massachusetts Institute of Technology (Dori et al, 2003). Both SCALE-UP and TEAL are physics projects which incorporated both space redesign and course redesign, to change classes from teacher dominated lectures to classes that were more active, collaborative and problem solving focused. These projects demonstrated increased class attendance, reduced failure rates and improved student conceptual understanding. Walker et al. (2011) from the University of Minnesota, also found that student learning improved when tertiary teachers incorporated more active, student centred pedagogical approaches when they moved to new learning spaces. Whiteside et al. (2010), also from the University of Minnesota, found that even when teachers try to be consistent when teaching the same course to students in traditional and new learning spaces, different learning environments affect teaching and learning activities.

The TEAL and SCALE-UP projects have been criticized for not excluding confounding factors from their research design (Brooks, 2011). For example different staff taught students in different ways (traditional vs more collaborative) and in different spaces (traditional and new). Brooks (2011), from the University of Minnesota, in an effort to overcome the confounding factors of the TEAL and SCALE UP research, conducted a quasi experimental study in which the same instructor taught the same curriculum in two different spaces (traditional and new) to two sections of first year Biology students (he also had each section taught at the same time of day, but on different days of the week). His research found that the student group in the new learning space, while as a group having a significantly lower ACT scores than the group in the traditional space, performed at the same level as the group in the traditional space. In effect they outperformed the traditional group. (ACT scores are USA national test results that students have before going to University and they are predictive of how well students will do at university). In a follow up article Brooks (2012) demonstrates through a small study of a single course, that the type of learning space shapes teacher and student behaviors.

The extent to which new spaces are an incentive for teachers to change their practice (to use the technology, to better engage students,) is still an unknown in the tertiary sector. There is little information about how academics use the new spaces, whether we change our teaching and assessment practices or whether we persist with our teaching approaches 'in spite of the new spaces'.

School based research in the USA has shown that school teachers made few changes to their teaching practice when moving into new spaces (Cuban, 2001). In Australia, in a review of new learning spaces literature in the School sector, Blackmore et al (2011) concluded that "…a participatory or 'generative design' process will improve teacher practices which in turn will benefit students' learning experiences" (p. 8). In effect they argued that significant professional development needed to be provided to school teachers when they were asked to teach in new learning spaces and that the curriculum needed to change along with the spaces.

Professional development for staff teaching in new learning spaces

This review will not report on the literature on professional development for tertiary teachers using new learning spaces. The RMIT University based OLT funded 'Not a Waste of Space' project, which

aims to design, trial and evaluate a continuous professional development approach for academics teaching in new learning spaces, will cover this work when it reports in October 2013.

Literature review implications for the LENS Research Network

This section on the implications of the literature for the LENS Research Network completes this literature review. I have chosen to use the Pedagogy/Space/Technology framework (Radcliffe et al., 2008) as an organizing framework for the implications of the literature for the LENS Research Network. This framework fits with research areas that are most relevant to RMIT University teaching staff.

Pedagogy

The review revealed gaps in the pedagogic NLS literature in the areas of:

- curriculum design;
- the impact of NLSs on teacher practice;
- the impact of NLSs on student learning outcomes;
- assessment;
- work integrated learning; and
- the internationalization of the curriculum.

Each of these areas is discussed in turn below.

Curriculum design and teaching practices

Very few articles discuss in detail changing the curriculum to support more student centred learning practices which NLSs are designed to foster. Exceptions are Beichner et al, 2007; Dori et al, 2003; Deslauriers et al 2011; and Walker et al. 2011. Two different types of research projects would usefully help to fill the gaps in this area. One project type would involve documenting a change in curriculum and comparing student outcomes pre and post the intervention. The second type of research in this area would be to design a project to determine if academics change their practice (curriculum etc) when they move to teach in NLSs.

Another gap in the curriculum literature relates to the development of employability skills in new learning spaces. NLSs are designed to foster collaborative learning and as such the opportunities for conducting research on teaching and assessing skills such as team work and communication are manifest.

Student outcomes

While some articles claimed that NLSs would improve student learning (Oblinger, 2005), most of the research in this area focused on staff and student perceptions and satisfaction with the space, not on student learning outcomes per se. Very little research demonstrated a change in student outcomes with the introduction of the new spaces, with the exception being the study by Brooks (2011). Several studies demonstrated that new learning spaces in combination with a changed curriculum did improve physics students learning outcomes (Beichner et al, 2007; Dori et al, 2003).

There is ample scope for research in different disciplines to compare student outcomes results between the same course taught in a new learning space and taught in traditional spaces, while holding all other variables constant (Brooks, 2011).

Assessment

While there appears to very little research to show that NLSs prompt a change in teaching practice (Brooks, 2012 studied a physics teacher's behaviour), there appears to be no research that studied whether academics change their assessment practices when moving to teach in NLSs. Arguably, while academics may change their curriculum to encourage student collaboration and the use of technology, anecdotally students are then assessed by very traditional means that may not necessarily assess the skills and knowledge that the curriculum fosters. A study comparing assessment practices pre and post NLSs occupation would advance the literature in this area. For

example, self and peer assessment are strategies that lend themselves to the assessment of collaborative learning in NLSs and future research could focus on the impact on student outcomes when using those strategies.

Another piece of research that would be useful for the sector would be the identification of assessment practices that assessed the types of student centred learning that NLSs are designed to foster: active, collaborative and peer-based approaches to learning that use technology.

Work integrated learning [contributed by Leoni Russell, RMIT University Learning and Teaching Unit]
Within the growing context of integrating WIL activities within curriculum to provide students with real world and relevant learning opportunities, many universities are broadening their view of WIL beyond work placements to consider project work on campus, in simulated workplace environments and virtually. This move to re-conceptualise WIL in other contexts apart from the workplace has partly been influenced by the growing competition for placements in industry and also by the recognition that quality WIL activities can take place in work-like, flexible learning spaces on campus.

Different approaches to WIL occur in a variety of places. Current research (via an OLT funded project titled "Assessing the impact of WIL on student work-readiness") is investigating the impact that different WIL types (in different places e.g. on and off campus) have on students' perceptions of their employability. To-date there is little research that considers how different approaches to WIL impact student learning and outcomes. As RMIT continues to integrate WIL activities into its programs, there is the opportunity to re-imagine and research how we might best engage industry and the community into our learning through our spaces.

Internationalization of the curriculum
There appears to be no literature on internationalising the curriculum through the use of new learning spaces. Given RMIT University's strategic imperatives as a global university, there are significant opportunities for research in this area. Pedagogic research that could be carried out includes:

- comparative studies of the same course taught in NLSs at Australian and overseas campuses;
- studying the impact on student outcomes by incorporating opportunities for students to work with overseas students through NLSs; and
- incorporating into courses literature from non western countries.

Potential research links would be with academics on RMIT campuses overseas, and academics from overseas institutions who teach the same courses that we teach.

Also
While the focus of this literature review has not been on the professional development of staff teaching in NLSs, there is question, asked by the school-based review of Blackmore et al. (2011) that is relevant to the tertiary sector. What fosters changes in pedagogical practices? In effect the question asks for research on the most effective ways to support teaching staff to use NLSs most effectively and with the best student outcomes. It is with great anticipation that we await the outcomes of the OLT funded 'Not a Waste of Space' project.

Space
The design and the evaluation of learning spaces has been the focus of the research literature in the sector over the last decade. Lee and Tan (2011) argue for the need for longitudinal and comparative research and for research that provides a richer evaluation by including, if relevant, less traditional evaluation strategies, such as narrative and ethnographic inquiry, and observational studies using video, movement tracking and group activities.

There are opportunities for research that uses Radcliffe et al's. (2008) PST framework to underpin the design of spaces and Lee and Tans' (2011) 'baseline model' to underpin the design of the evaluation of new learning spaces.

In a professionally focused university like RMIT, there also is an opportunity to work with industry to improve the acoustics in large spaces in which many students work collaboratively. There may also be an opportunity to work further with other industries in the design of furniture, technology and buildings. There is, therefore, potential for academics to work with architects, furniture providers, acoustics providers and property developers along with RMIT University Property Services, to research the design of learning spaces.

Technology

Technology is always in transition and as such, the key lesson learnt from the literature is the importance of future proofing spaces in terms of the technology used in the space. In part recent approaches to do this have focused on using technology that students bring to the spaces (lap tops, phone, tablets). There is therefore, some scope to conduct research into the use of mobile technology in NLSs to facilitate student learning outcomes. As such it may be useful for teaching staff to work with IT staff to research the impact of using of mobile technologies on student outcomes.

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