1.0 A Pedagogy-Space-Technology (PST) Framework for Designing and Evaluating Learning Places (D. Radcliffe)

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Over the past decade there has been a growing body of knowledge and working examples of new approaches to the design of learning spaces in higher education institutions. Despite this, a clear consensus is yet to emerge. A number of factors are driving innovation and experimentation in the design of learning spaces in North America, Europe and Australia. These include changing social patterns, generational change, a changing funding environment, new and emerging technology and the shift to a more learner-centred pedagogy.

There has been a tendency for many initiatives in learning spaces to be technology-driven (Long 2005; Valenti 2002) or to a lesser extent pedagogy-driven. On occasions both technology and pedagogy are considered in tandem (Brown 2005; JISC). Somewhat differently, Jamieson *et al.* (2000) examines the pedagogy-place nexus. Where pedagogy is a focus, these initiatives adopt some explicit form of learner-centred or constructivist pedagogy paradigm (Brown 2005; Oblinger 2005).

Moore and co workers (2006) observe that as a response to the different approaches to learning and sensibilities of the next generation, "some faculty have changed teaching strategies simply to recapture the attention of students who are net-surfing, instant-messaging, and text-messaging during scheduled meetings". They go on to argue that "creating learning environments that challenge students to become actively engaged, independent, lifelong learners inside and outside of formal learning spaces should be the critical aim of change in teaching strategies".

In reality there is a nexus between pedagogy, technology and the design of the learning space. There are real and virtual dimensions to each of these and this nexus is now being recognised and discussed. For example a recent paper by Oblinger (2005) concludes that "the convergence of technology, pedagogy and space can lead to exciting models of campus interactions."

This paper presents the Pedagogy-Space-Technology (PST) Framework for guiding the design of learning spaces which takes account of these three factors in informing the conceptual design and post-occupancy evaluation of either discrete learning environments (e.g. individual rooms) or networks of places (e.g. a whole campus).

Innovative Learning Spaces

In the United States of America there are several collaborative initiatives, consortia and consultancy groups active in developing innovative learning environments, including:

- The National Learning Infrastructure Initiative (NLII), sponsored by Educause, and their Learning Space Design Constitutive Group
- Student-Centered Activities for Large Enrolment Undergraduate Programs (SCALE-UP) at North Carolina State University to develop a highly collaborative, hands-on, computer-rich, interactive learning environment for large enrolment courses.
- The Kaleidoscope Project which is focused on developing learning environments that support undergraduate study in science, technology, engineering and mathematics (STEM).
- The Teaching Learning and Technology (TLT) Group

There are an increasing number of exemplars of next generation learning spaces, often associated with the various consortia listed above. Some like the Technology Enabled Active Learning (TEAL) project at Massachusetts Institute of Technology (MIT) (Long 2005) and the Learning in a Technology-Rich Environment (LITRE) at North Carolina State University have a particular focus on technology.

Others, like Wallenberg Hall at Stanford University, combine technology with a flexible architecture and mobile fittings. The Stanford Centre for Innovations in Learning, responsible for Wallenberg Hall, focuses on people, places and processes, although there is also a strong theme of advanced technology, especially web-based tools.

The history of the Integrated Learning Centre at the University of Arizona highlights the importance of having the right people involved at each stage in the development of new learning spaces. At the inception the visionary and the key (political) allies are the key drivers. During the conceptual design the "grounded dreamers" need to be brought on board and should be drawn from students, staff, teaching consultants, instructional technology specialists, facilities designers and Information Technology specialists. They argue that the planners including the architect and the project manager only need join by the time of detailed design; although this is contestable. By the time of construction the builders, contractors and sub-contractors have joined the team. In the early years of occupation all the people involved to this stage should be the promoters of the initiative.

The Integrated Learning Centre (ILC) in the Faculty of Applied Sciences at Queen's University, in Kingston, Ontario (Canada) was conceived with several purposes in mind. These included having a learning environment that supported a major piece of curriculum reform based on a shift to a more active and project-based approach. They also sought to use the building itself as a learning tool and encouraged integration of academic staff from different departments through a common, overlapping space at the intersection of several

existing buildings. The ILC, opened in 2004, contains design and teaching studios, prototyping, instrumented plazas, active learning centre and site investigation facility, competitive teams' spaces, group rooms and live (green) building. The ILC learned lessons from the earlier Integrated Teaching and Learning Lab and the Discovery Learning Centre, at the University of Colorado in Boulder and other innovative laboratories. Thus new initiatives build upon earlier ones (McCowan & Mason 2002).

The University of Waterloo (Ontario, Canada) established the Flexible Learning Experience (FLEX) Lab in 2000 to "support pedagogical innovation". The focus is on achieving benefits for both the teachers and the students. They encourage experimentation and innovation, tracking results and sharing these with colleagues.

The report "Designing Spaces for Effective Learning, guide for the 21st century learning design" (JISC) explores the relationship between learning technologies and innovative examples of physical space design. There are several examples that are of particular relevance to this project. The InterActive ClassRoom built in 1998 in Mechanical Engineering at Strathclyde University, Glasgow, Scotland relates to the ACTS (Advanced Concept Teaching Space) concept proposed here. Intended to encourage more student interaction via a Socratic dialogue method, the room has relatively conventional facilities with slightly curved desk tops plus the addition of a polling system – the Personal Response System. In 2000 the University built the first of its new Teaching Clusters to encourage collaborative learning. There is little detail on these clusters, so it is difficult to compare with for example the CLCs (Collaborative Learning Centre). More recently they created a product realisation studio based on a similar one in Rensselaer Polytechnic Institute (USA). They claimed that "overall the change to active teaching styles, with collaborative learning, has been a huge success – both in terms of student performance and retention. An independent evaluation was carried out a couple of years ago" and several student quotes are provided (NATALIE 2006).

The JISC (Joint Information Systems Committee) report provides some general advice on the design of learning centres and a generic floor plan but very little by way of specific examples. The Saltire Centre at Glasgow Caledonian University is highlighted. It is a large informal space that provides a hub – "the social heart" for the university; it physically connects different parts of the campus and also provides wireless connectivity. It has social and civic spaces and glazed atrium that provides natural lighting and ventilation as well as an exhibition space. The Centre incorporates a student services mall and a learning café. The upper floors contain the library facilities in relatively informal layout with some formal seminar rooms (Saltire 2006).

Next Generation Learning Spaces (NGLS) Project

In 2006, the Carrick Institute for Teaching and Learning in Higher Education in Australia funded a national project called Next Generation Learning Spaces. This project is focused on what happens in learning spaces and seeks to create a coherent and comprehensive framework for guiding the design and operation of new learning spaces. The primary goal is to fully develop, rigorously test in the field, thoroughly evaluate and disseminate widely a new design framework. It will be in a form that allows the concepts to be generalised and replicated in new and different applications, nationally and internationally. This new framework has been developed through a collaborative, interdisciplinary and participatory process, drawing on knowledge from all the stakeholder groups.

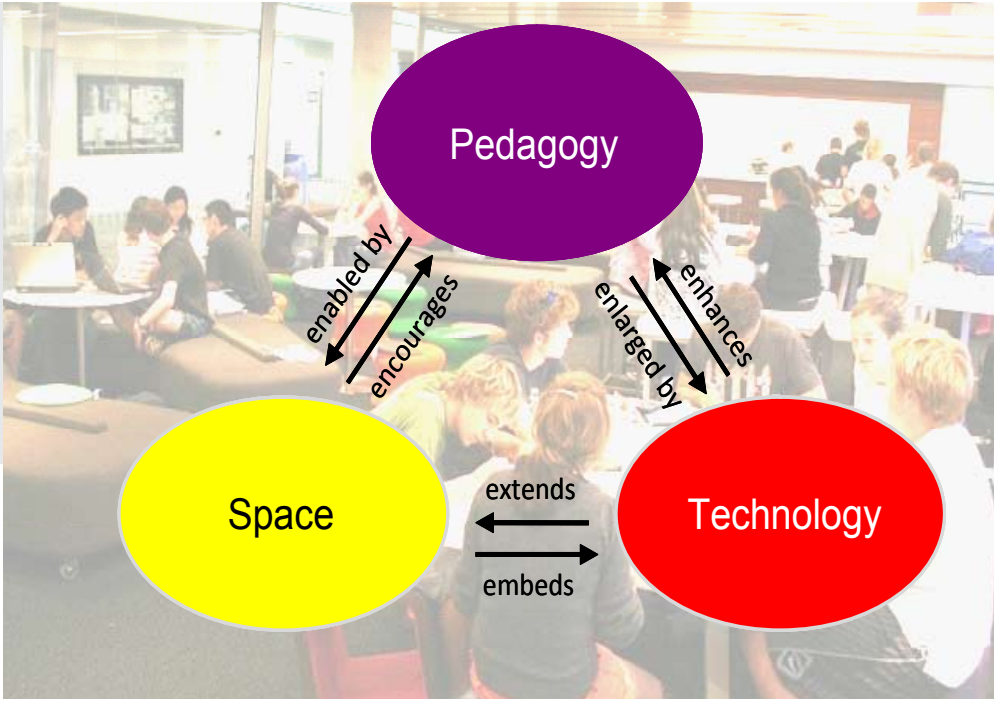
The scope of the project includes the design, demonstration and evaluation of three distinct types of learning environments using this unified approach that have been pioneered at the University of Queensland. The three space types are: next generation libraries (connected learning experiences beyond information), collaborative learning centres (challenging our assumptions and pushing the boundaries) and advanced concept teaching spaces (the interactive lecture theatre of the future). While there is some knowledge and experience on the use of these new forms of learning space there is still much to discover.

The project is based at the University of Queensland which has a track record of innovation in teaching and in the design and provisioning of new learning spaces. The project is led by a small team of co-principal investigators who have overlapping interests and complementary expertise in the design of learning environments from the perspectives of pedagogy, space and technology. The team includes a senior faculty member with a history of innovation in teaching, an architect who has designed numerous new spaces in universities and high schools, and a university-based manager of teaching technology.

The project has engaged a large number of people representing a diverse range of stakeholders; learners, teachers, learning support staff, administrators and design and technology professionals at the University and nationally. This agrees with the recommendation of Oblinger (2005) that the following groups should be "at the table" when designing new learning spaces: Administration, Faculty, Students (undergraduate and postgraduate), Facilities, Planning, Information Technology, Library and Teaching and Learning Support.

A key feature of the project's engagement and dissemination has been a series of national forums on Next Generation Learning Spaces, the first of which was held in July 2007. This event provided an opportunity for the diverse stakeholder group to experience the new learning spaces at the University of Queensland. Various sessions were held in the new spaces with forum delegates undertaking interactive exercises designed to demonstrate the features of the different spaces. The first forum also provided an opportunity for other universities to showcase the learning space they were most proud of.

To complement the forums, the University has hosted numerous delegations of visitors who have inspected the new facilities and the project



team have presented at other regional events and national conferences concerned with aspects of new learning spaces. The latter has been achieved in part through active networking with peak stakeholder groups throughout the project to gather input and to critique ideas. These include the Higher Education Research and Development Society of Australasia (HERDSA), the Deputy Vice-Chancellors (Vice Presidents) for Academic Affairs, the Tertiary Education Facilities Management Association, the Association for Tertiary Education Management, and the Association of Educational Technology Managers (AETM).

The major transferable outcome of the project will be the new design framework based on the pedagogy-space-technology nexus. This framework will provide a robust basis for developing design briefs, for assessing alternative concepts and for evaluating new learning environments. It will be in a form that allows the concepts to be generalised and replicated in new and different applications. The project is developing detailed case studies that get into the 'nitty gritty' of what really works and what does not, based on the development and evaluation of these three new spaces and their predecessors. These case studies will illustrate the operation of the new design framework.

Design Principles for Learning Spaces

A number of authors have proposed lists of design principles or similar as guides in the creation of contemporary learning spaces. There is no generally agreed approach to the creation of new learning spaces and various groups are promoting particular sets of guiding principles for the creation of such spaces. Some of these lists of principles are aspirational while others imply they are based on experience. However there is really very little objective data based on well-documented case studies or analysis that can be used to test these. As well there is little or no empirical evidence provided to support the proposed principles.

The JISC report argues that "a learning space should be able to motivate learners and promote learning as an activity; support collaborative, as well as formal, practice; provide a personalised and inclusive environment; and be flexible in the face of changing needs". It states that the design of individual spaces within an educational building needs to be:

- Flexible – to accommodate current and evolving pedagogies;
- Future proofed – to enable space to be re-allocated and reconfigured;
- Bold – to look beyond tried and tested technologies and pedagogies;
- Creative – to energise and inspire learners and tutors;
- Supportive – to develop the potential of all learners; and
- Enterprising – to make each space capable of supporting different purposes.

Oblinger (2005) takes a more focused and learner-centred approach to the design of facilities:

- Design learning spaces around people
- Support multiple types of learning activities
- Enable connections, inside and outside
- Accommodate information technology
- Design for comfort, safety and functionality
- Reflect institutional values

Jamieson *et al*. (2005) promote the adoption of multi-disciplinary approaches and the use of participatory design processes and offer the seven guiding principles to be used for "augmenting rather than replace in toto existing design principles" as follows:

- Design space for multiple use concurrently and consecutively
- Design to maximise the inherent flexibility within each space
- Design to make use of the vertical dimension of facilities
- Design to integrate previously discrete campus functions
- Design features and functions to maximise teacher and student control
- Design to maximise alignment of different curricula activities
- Design to maximise student access to and use/ownership of the learning environment

Dension University, a small liberal arts college in Ohio, established the Learning Spaces Project to "to enhance the utility, appearance and comfort of all campus spaces related to learning. Learning spaces must support many styles of learning, be versatile, comfortable and attractive, rich with information and reliable technology, maintained and accessible" (Siddall 2006). They present the following set of design guidelines:

- Learning spaces should support a diversity of learning styles
- Learning spaces must be versatile
- Learning spaces must be comfortable and attractive
- Learning spaces are information rich and technologically reliable
- Learning spaces must be maintained continuously
- Learning spaces should be ubiquitous in space and time
- Learning spaces should be used effectively
- Sufficient resources must be allocated for learning spaces

Johnson and Lomas (2005) point to a series of steps that combine "to create an iterative dialogue among the design team and other stakeholders in the design process." The process suggested is organic and begins by considering the institutional context (its values, strengths and limitations) and the learning principles that are to be promoted.

These reflect concepts in classic works like Chickering and Gamson's "Seven Principles" (1987) or the more recent NRC (National Research Council) report on "How People Learn" (2000). It is recommended that the design team works from the desired learning principles to define a set of learning activities that will promote these principles. The design principles flow from learning principles and the learning activities. Thus there is not a single universal set of design principles but a particular set that meet the needs of a given project. It is only after the design principles are established that the requirements for the particular setting are derived. Johnson and Lomas go on to emphasise the importance of considering how to measure success in the design of new learning environments.

Taking yet another tack, Long and Ehrmann (2005) suggest four ideas that are useful in imagining the classroom of the future; Learning by Doing Matters; Context Matters; Interaction Matters and Location of Learning Matters.

They proceed to list the characteristics of the "classroom of the future" as:

- Designed for people, not for ephemeral technologies
- Optimised for certain learning activities; not just stuffed with technology
- Enabling technologies brought into the space, rather than built into the space
- Allowing invisible technology and flexible use
- Emphasising soft spaces
- Useful across the 24hr day
- Zoned for sound and activity

While these various lists offer general design principles for guidance, they are difficult to apply in practice with a multi-disciplinary team of stakeholders in the creation of new learning spaces. The style of the pithy taglines is rather high-minded and universal and thus ambiguous; attractive to 'big-picture' thinkers but not so to stakeholders concerned about the specifics.

Proposed Pedagogy-Space-Technology (PST) Design & Evaluation Framework

Based on the preliminary findings from the NGLS Project, we propose the following question-based framework to aid diverse stakeholders to approach the creation, operation and evaluation of new learning spaces. The framework invites stakeholders including administrators, faculty, architects, students, equipment and technology providers at each stage of the conception, development, realization and use of a new learning space to reflect on what they are doing and why. It is inherently self-documenting and aides the elicitation of lessons learned for future projects.

In recognition that each of these stakeholder groups has a particular set of background assumptions, expectations and practices about how they should or could contribute to the realization of a new learning space project, the framework is not in the form of a prescriptive model of the design or delivery process per se. A model-based approach would tend to privilege those who were familiar with that particular form of representation, depending on what type of model was used or how it was presented visually. For instance if the framework were constructed around a model of the design and delivery process familiar to architects, this might not mean very much to a faculty member from the liberal arts who is trying to evoke a particular learning experience or an administrator who is focused on project management issues like cost and risk. By using a series of generic trigger questions all stakeholders potentially have equal access to the design conversation.

One reason for keeping the framework simple was to enable it to be used in a wide range of project types and scales and institutional contexts. An objective of the NGLS is to try to get comparative data from many different projects across the country, both current and completed, so that it is possible to identify patterns in what different institutions are trying to achieve, how they do this and how they evaluate success. Obviously additional and more detailed questions can be added in each section and at each stage as fitting the particular instance.

The sequencing of the items in the framework is intentional and important. Each of the three elements, pedagogy, space and technology, influence each other in a reciprocal fashion. Thus achieving a desired pedagogy might suggest a preferred way to arrange the shape and use of space, equally a learning space irrespective of its intended use will tend to shape what people do in it and hence the patterns of teaching and learning. Similarly a particular space places constraints (or presents opportunities) for the introduction of certain type of technology while a given technology can impact how a space is used by teachers and students. Thus while all three are interdependent in a cyclical manner, the question remains; which element do you start with? Pedagogy seems to be the logical first element, then space and finally technology.

However this is not to suggest a hierarchy or to value pedagogy more than space or technology. Rather it is a recommended place to enter the pedagogy-space-technology loop in order to go through an iterative process. Ideally such iteration would occur several times at each stage of the life-cycle of a learning space (cradle to cradle). While only two life-cycle stages are represented in the Table 1 (as the columns - Conception & Design and Implementation & Operation), the framework could be made more fine-grained by splitting these into more than two columns corresponding to more life-cycle stages and writing appropriate questions to each stage. Thus if a particular institution has a prescribed set of project stages with decision points (stage gates), then the basic PST framework questions can be re-written to suit the declared delivery steps or stages for the institution; it can be tailored to meet particular ways of doing work.

Table 1 - Pedagogy-Space-Technology (PST) Design & Evaluation Framework

Life-Cycle Stage		
Focus	**Conception and Design**	**Implementation and Operation**
Overall	What is the motivation for the initiative? What is intended? What initiated the project? Who are the proponents and opponents? Who has to be persuaded about the idea? Why? What lessons were learned for the future?	What does success look like? Is the facility considered to be a success? By whom? Why? What is the evidence? Does this relate to the original motivation or intent? What lessons were learned for the future?
Pedagogy	What type(s) of learning and teaching are we trying to foster? Why? Why is this likely to make a difference to learning? What is the theory & evidence? What plans will be made to modify programs or courses to take advantage of the new facilities? What education or training for academics and other staff is built into the plan?	What type(s) of learning and teaching are observed to take place? What is the evidence? What evaluation methodology or approach was used and what methods were used to gather and analyse data? Who was included in the data gathering and analysis? Students? Faculty? Staff? Administrator? Senior Leadership? Facilities managers and technology staff?
Space (including environs; furniture and fittings)	What aspects of the design of the space and provisioning of furniture and fittings will foster these modes of learning (and teaching)? How? Who is involved in developing the design brief? Why? Which existing facilities will be considered in developing concepts? Can we prototype ideas? Who is involved in the assessment of concepts and detailed design? Why? What are their primary issues and concerns?	Which aspects of the space design and equipment worked and which did not? Why? What were the unexpected (unintended) uses of the space and facilities that aided learning or facilitated teaching? Do these present ideas for future projects? How was the effectiveness of the use of space to aid learning and teaching measured? What were the different metrics used? Where there synergies between this and other spaces that enhanced learning?
Technology (ICT; lab and specialist equipment)	What technology will be deployed to complement the space design in fostering the desired learning and teaching patterns? How? In establishing the brief and developing concepts and detailed designs, what is the relationship between the design of the space and the selection and integration of technology? What pedagogical improvements are suggested by the technology?	What technologies were most effective at enhancing learning and teaching? Why? What were the unexpected (unintended) impacts (positive and negative) of the technology on learning and teaching? How did technology enhance the continuum of learning and teaching across the campus and beyond?

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