MONASH University

New Generation Learning Environments in Higher Education

Joanne Dane
B.A. (Interior Design)

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Faculty of Art Architecture & Design
Department of Design

Abstract

A small number of experimental classrooms were developed by universities around the turn of the 21st century. They were unique due to the collaboration between facility manager and academics who recognised that their preferred student-centred approach to teaching and learning could not be activated in traditional learning environments such as lecture theatres, tutorial rooms and computer laboratories. Several academics published accounts of their successful experiences of teaching in these experimental classrooms, heralding a new discourse on the topic of a new generation of learning environments (NGLEs).

NGLEs have been defined in this study as *a single space or suite of settings designed to improve teaching and learning through the provision of physical environments that will enable more student-centred teaching and learning processes*. They have paralleled efforts by universities to shift from teacher-centred teaching, to student-centred learning, in response to compelling research into how students learn within a higher education context. That research presents a picture of student-centred learning – and more specifically 'effective teaching and learning' – that is inherently active, collaborative and interactive.

This study also explores the field of environmental psychology, a discourse focused on the causal effect of the physical environment on human behaviour and the premise that the physical environment can be designed to enact specific human behaviours. In this sense, the author of this study has explored the relationship between effective teaching and learning, as described in the educational literature, the reciprocal behaviours associated with effective teaching and learning and the consequential spatial characteristics that enable effective teaching and learning to take place.

By 2005, a number of Australian universities had invested in developing their own versions of NGLEs. The author of this study was curious as to how these NGLEs had been designed: was there an explicit pedagogical narrative expressed during the design process? Did teachers plan their teaching activities in response to the affordances of the physical environment? Did students and teachers enact the types of behaviours representative of effective teaching and learning? Therefore, the research question underpinning this study is: **How have new generation learning environments in higher education been conceptualised pedagogically, and designed physically, to enable effective teaching and learning?** This study adopted a case study methodology to evaluate four early examples of NGLEs, culminating in two unique outputs of this study:

1. **The Effective Teaching and Learning Spatial Framework**: a theoretical framework that unites the parallel fields of student learning research and environmental psychology, culminating in eight spatial characteristics common to NGLEs.
2. **The Effective Teaching and Learning Evaluation Tool**: a simple and easy-to-use survey tool based upon 25 'possibility statements', resulting in an efficacy rating of the classroom. A classroom is defined as a NGLE if it achieves an efficacy rating of 80 or above.

Through a longitudinal approach to this research study, the author has tracked developments in NGLEs since evaluating the case study examples, highlighting the key spatial features that have presented as core features of NGLEs. These observations reinforce the development of NGLEs as a crucial space typology on university campuses, to enable wholesale application of student-centred teaching and learning.

Declaration

This thesis is an original work of my research and contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signature:

Print Name: Joanne Dane

Date: 14th August 2019

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This work is dedicated in loving memory of my mother, father and brother.

1 Elite Editing, 213 Greenhill Road, Eastwood SA. www.eliteediting.com.au

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Glossary

ANU	Australian National University
AVM	Audio Visual Manager
CEDAM	Centre of Educational Development and Academic Methods
CEFPI	Council for Educational Facility Planners International
CTLC	Collaborative Teaching and Learning Centre
DETYA	Department of Education Training and Youth Affairs
DILE	Deakin Immersive Learning Environment
EE	Electrical Engineering
EE PBL	Electrical Engineering Problem Based Learning (precinct)
FELS	Framework for Evaluating Learning Spaces
HES	Higher Education Standards
HESF	Higher Education Standards Framework
GPO	General Power Outlet
IEQ	Indoor Environment Quality
ILO	Intended Learning Objective
JISC	Joint Information Systems Committee
LCD	Liquid Crystal Display
LED	Learning Environment Designer
LEaRN	Learning Environment Applied Research Network
LSRS	Learning Space Rating System
LTB	Learning & Teaching Building (Monash University)
MIT	Massachusetts Institute of Technology
Mo-CoW	Mobile Computing on Wheels
MOOCs	Massive Open Online Courses
NGLE	New Generation Learning Environment
OECD	Organisation for Economic Co-operation and Development
PEB	Programme on Educational Building
POE	Post Occupancy Evaluation

PST	Pedagogy-Space-Technology (Framework)
RMIT	Royal Melbourne Institute of Technology
SAB	Swanston Academic Building
SCUP	Society of College and University Planners
SES	Steelcase Education Solutions
STEM	Science, technology, engineering & maths
TA	Teaching Assistant
TEAL	Technology-Enabled Active Learning
TEDI	Tertiary Education Development Institute (University of Queensland)
TEFMA	Tertiary Education Facility Managers Association
TESQA	Tertiary Education Quality and Standards Agency
TLA	Teaching and Learning Activities
TM	Technology Manager
WB	Whiteboard
WSU	Western Sydney University
UNSW	University of New South Wales

Prologue

This thesis represents a body of work that has spanned seventeen years traversing two careers, one in academia and the other in design practice, and therefore warrants some explanation. The topic of this research study, the Design of New Generation Learning Environments (NGLEs) in Higher Education, chronicles the emergence and development of a new learning space typology on university campuses, a type of learning space designed to align with student-centred pedagogies such as collaborative learning, problem-based learning and peer-to-peer learning.

In 2003, as an academic in the field of design – and new to teaching – I completed a Graduate Certificate of Higher Education. As a result of engaging with the teaching and learning literature, particularly in relation to student-centred learning, I became aware of a disconnect between the practice of student-centred learning and the choice of classroom typologies provided to teachers on campus. It was apparent that student-centred pedagogies were significantly compromised when delivered in lecture theatres and classrooms designed for teacher-centred practices. Any teachers wanting to implement student-centred pedagogies were provided little choice of classroom other than the suite of traditional teaching spaces on campus (notably lecture theatres, seminar/tutorial rooms and computer laboratories). Even more significant for me, it was apparent that very few design practitioners were cognisant of this 'gap', resulting in an absence of awareness by architects and designers of the pedagogy-design disjuncture. This epiphany portended a career path that eventually enticed me back to the practice of design.

Around the same time as my observations of this disconnect, a small number of experimental NGLEs were being built in Australia. They had been developed in consultation with academics who not only taught in these new spaces, but published papers of their experiences. These early examples paved the way for a new discourse relating to the development of new generation learning environments on university campuses, and further boosted by federal grant funding to support the pedagogical development of NGLEs (Carrick Institute, 2007). My interest in this emerging field led to PhD candidature.

The literature review (Chapter 2) led to the first of two unique contributions to knowledge associated with this PhD study, the Effective Teaching & Learning Spatial Framework. This framework, detailed in Chapter 3, provides the theoretical foundations of the thesis, connecting education theory with human behaviour and proposing a series of relational spatial characteristics.

As my research ideas developed and more examples of NGLEs emerged, I established a case study methodology for mapping design intentions, teaching intentions, as well as teaching and learning behaviours to be observed in each NGLE. Four case studies were identified, piloted and evaluated for the present study (refer chapters 5 – 8), looking through the lens of the Effective Teaching & Learning Spatial Framework.

In 2010, as the case studies were being analysed and finalised for the current study, I was presented with the opportunity to return to design practice, to apply the research into the design of new generation learning environments. This shift in career undoubtedly resulted in a remission of attention to the thesis, although not a lack of interest.

Despite the slowing down of effort towards the thesis, my interest in the field of designing new generation learning environments – and participation in the discourse – continued to escalate. The initial body of research informing the thesis aligned with demand for practical knowledge in the design of new generation learning environments. Engagement in planning and design of NGLEs afforded me tremendous exposure to the institutional tensions and issues to overcome, in order for NGLEs to be established as a critical, yet complementary space typology on university campuses.

During this time of design opportunity, I continued to draw upon the thesis material, culminating in an authentic research-based design practice. I felt more connected to the thesis than ever, as a result of being able to apply the knowledge into practice. With an intrinsic belief that the research findings remained relevant, I was determined to complete the thesis. It was during this time in design practice that the second unique by-product of this thesis developed, the Effective Teaching & Learning Evaluation Tool. As is described in the literature review, post occupancy evaluation (POE) of NGLEs has become notoriously complex and fraught with implementation difficulties. The POE tool developed for this study enables simple and effective POE measures, which have been tested through the design of a variety of NGLEs.

While I acknowledge that the case studies in this thesis may have aged compared to more recent examples, I am convinced that the knowledge extracted from them are as relevant today as they were in 2008. Without the experiences and insights from these case studies, designing the next generation of NGLEs would not have been as affective.

As unconventional as it is for a PhD study to span such a distance of time, I believe there have been unequivocal benefits:

– It has presented the opportunity to test the theoretical construct (the Effective Teaching & Learning Spatial Framework) in practice, through the design of new generation learning environments

– The Effective Teaching & Learning Evaluation Tool emerged in practice in response to demand for evaluating the new generation learning environments I had been involved in designing

– The Effective Teaching & Learning Evaluation Tool derived specifically from the Effective Teaching & Learning Spatial Framework and the two are inextricably linked. The evaluation tool could not have been conceived without the framework.

– The longitudinal nature of the thesis has enabled a perspective demonstrating how new generation learning environments have developed, including examples in the early 2000s through to the present time

– The return to practice – and interactions with university clients – exposed me to the breadth of institutional processes and external factors that can impact the perceived success of new generation learning environments.

Having been in practice for almost ten years, I continue to constantly draw upon the thesis material. Its resonance continues to inform my design practice and interactions with higher education and design colleagues. The unique contributions, the Effective Teaching & Learning Spatial Framework and The Effective Teaching & Learning Evaluation Tool, have formed an inextricable part of my current practice, made possible by the prolonged commitment to the field of designing new generation learning environments.

Chapter 1: Introduction

1.0 INTRODUCTION

This study is concerned with efforts within universities to implement a ‘new generation’ of classroom spatial types that are explicitly intended to support the implementation of student-centred approaches to teaching and learning. This directly contrasts with traditional lecture theatres and tutorial rooms that are well suited for teacher-centred teaching. These new generation learning environments (NGLEs) are defined by the author as *a single space or suite of settings designed to improve teaching and learning through the provision of physical environments that will enable more student-centred teaching and learning processes*. They have emerged in response to the need for universities to provide a wider range of campus settings to facilitate greater student engagement, providing alternatives to the predominant didactic pedagogy conducted in traditional lecture theatres and, to a lesser degree, in tutorial rooms.

NGLEs are distinct from other types of specialist timetabled teaching and learning spaces such as art and music studios, science laboratories and technical workshops. These specialist teaching and learning experiences have existed for decades within particular fields such as fine art, music, science and health, where students have gained practical experience as part of their coursework. Depending on the field of study being undertaken, some students spend significant time in timetabled specialist spaces undertaking practical experiences, whereas other students spend the majority of time in timetabled general purpose classrooms such as lecture theatres, tutorial rooms and computer laboratories.

This study is concerned with the development of a new space typology in which student-centred learning is possible, presenting an alternative to the de rigueur of lecture theatres and tutorial rooms. With the emergence and development of new generation learning environments in higher education, the critical question underpinning this research study was: *how have new generation learning environments been conceptualised pedagogically, and designed physically, to enable a student-centred approach to teaching and learning?*

Research into student-centred learning emphasises the fundamental fact that it is the student who does the learning in response to the teaching stimulus (Entwistle, 1987b; Ramsden, 1992; Shuell, 1986). Such research contends that learning is more effective when the teacher implements relevant and contextual activities to engender a deep understanding of concepts for the students (Marton, Hounsell & Entwistle, 1984; Prosser & Trigwell, 1999; Ramsden, 1992). Activities planned to develop and retain new knowledge and skills may be undertaken independently or collaboratively, but the fundamental concept is that students will be 'doing' activities – in the classroom – to generate their learning. As Ramsden asserts, 'it is what students do, rather than what teachers do, that ultimately determines whether changes in their understanding actually take place' (2003, p. 126).

Research into student-centred learning is notable for establishing a clear sense of what effective teaching and learning looks like, in terms of desirable practice and classroom behaviour. From the perspective of this study, the student learning research discourse is of even greater note for the conspicuous absence of any real sense that teaching and learning 'takes place' in physical environments that are integral to the pedagogical process. Consequently, the student-centred learning discourse offers little insight into how student-centred approaches to teaching and learning may be implemented in typical university classrooms designed for a traditional, didactic pedagogy. Most particularly, the discourse makes little attempt to prescribe the physical characteristics of classrooms explicitly designed to optimise the likelihood that student-centred learning will occur.

In contrast, research in the field of environmental psychology contends that the physical environment affects how people behave in an environment and, conversely, that the environment can be designed to increase the likelihood of certain behaviours being enacted (Gifford, 2002; Lawson, 2001; Proshansky, Ittelson & Rivlin, 1970b). This study asserts that by building the environmental psychology research, learning environments may be designed to offer greater opportunity for the teacher to teach in ways that will facilitate improved learning and increase the likelihood of effective teaching and learning behaviours being enacted. Therefore, this study contends that the design and implementation of NGLEs occurs at the critical conjuncture of the theory of effective teaching and learning and the field of environmental psychology.

The imperative to encourage a greater percentage of the population to achieve a degree qualification (Bradley, 2008) is driven by research findings confirming that the economic growth and sustainability of a country is explicitly linked to the provision of high-quality tertiary education (State of Victoria, 2010). However this development, fuelled by government policies, has placed tremendous pressure on universities to provide infrastructure for growing student populations—pressure that has been significantly resolved through the increased implementation of large-format teaching in lecture theatres (Allais, 2013; Arvanitakis, 2013; Hornsby & Osman, 2014).

The predominance of lecturing in universities must be viewed in light of the results of educational research that emanated from the latter part of the 20th century which contends that large-format teaching is not the most effective way for students to learn (Bligh, 1972; Laurillard, 2002; Penner, 1984). This research postulates that long, didactic and passive lectures result in wavering student concentration and difficulty in developing an understanding or connecting and contextualising content through purely cognitive processes. Educator Diana Laurillard describes lectures for students as "a grossly inefficient way of engaging with academic knowledge. For the institution it is very convenient, and so, despite the inconvenience to the students, who have to fit to its logistical demands, and despite its pedagogical value, it survives" (Laurillard, 2002, p.94).

In the last twenty years there has been a growing interest within universities to improve the quality of the student learning experience. This is evidenced by institutional Strategic Plans that explicitly state the value of adopting more student-centred pedagogies (Davis, 2015; Gardner, 2015; Gonski, 2015). Most universities have professional development programs for teachers, whereby they can improve their teaching skills. For example, the University of Melbourne conducts a Graduate Certification of Higher Education through the Centre for the Study of Higher Education (CHSE, 2018). The University of New South Wales provides a range of teaching courses, including: *Beginning to Teach Program*, *Foundations for University Teaching and Learning* and *Further Studies in Higher Education* (UNSW, 2019).

Australian universities appear to be making definitive attempts to improve the quality of teaching and learning through the strategic promotion of student-centred learning, teacher-development programs and implementation of innovative pedagogies. Although lectures continue to prevail as a significant learning experience for students on campus, the implementation of innovative pedagogies has led to rethinking the design of formal classroom infrastructure.

1.0.1 Procuring New Buildings on the University Campus

University custodians have a long history of investing in landmark architecture for a host of reasons such as reflecting the university or faculty brand; stimulating the intellect; attracting research partners; and attracting the best staff and students. In a major work outlining the history of, and critical trends in the development of the university campus, architect Brian Edwards claims 'the need for new buildings to express or challenge values beyond the utilitarian is arguably the distinguishing feature of the best of university architecture' (2000, p3). The method for procuring and designing iconic architecture focused on urban planning and the exterior aesthetic in deference to functionality of the teaching activities within (Dober, 2003; Edwards, 2000). Functional briefs for teaching spaces were commonly limited to the number and capacity of lecture theatres, tutorial rooms and laboratories, assuming that teaching and learning behaviours were known and accepted. This is demonstrated in the most recent edition of the Tertiary Education Facility Managers Association *Space Planning Guidelines* whereby the only "centrally timetabled teaching spaces" listed are lecture theatres, tutorial and seminar rooms (TEFMA, 2009, p. 13). These Guidelines serve as a benchmark across all participating Australian universities and provide architects and designers the primary source of university space planning requirements. Therefore, the contemporary university's propensity to fundamentally organise academic activities around lectures and tutorials reflects a longstanding view of how learning is understood to be transacted in the university and, most significantly for this study, the spatial settings where teaching and learning is to take place.

Despite the intentions of iconic university architecture to reflect the institution's intellectual pursuits, such buildings often fail to advance the core university experience of teaching and learning. Landmark buildings designed with provocative form, engineering feats and technological frontiers frequently house lecture theatres reminiscent of the earliest forms of lecture theatres. This is demonstrated effectively in the Stata Centre designed by world-renowned architect Frank Gehry (see Figures 1-4).

The Stata Centre challenges the observer with its chaotic forms and materiality (Figure 1), which Gehry is reported to have likened to 'a party of drunken robots' (Rimer, 2004). Gehry describes one of his design intentions as enabling the 'collision of ideas' (Joyce, 2004), providing opportunities for academics, researchers and students to literally bump into each other, with facilities for spontaneous interaction and knowledge sharing.

Indeed, the ground floor concourse (Figure 2) does exhibit an interactive 'street' with a multiplicity of meeting spaces and adjacent blackboards, the remnants of past scholarly 'collisions' remaining visible for passers-by (Figure 3). However, when the doors to the ground floor lecture hall open (Figure 4), students are confronted with the familiar setting of 250 tiered seats directed towards the lecturer's podium—an environment designed for didactic, teacher-led instruction.

1.0.2 Reorienting the Foundations of Higher Education Pedagogy

While universities frequently demonstrate their philosophical support for student-centred learning through their Strategic Plans, they are compelled to maintain large-format lectures, not only to manage student numbers and economic viability, but because of the established traditions of university teaching practice and expectations around the experience of attending university. Diana Laurillard concedes that changing old paradigms of teaching and learning is a difficult proposition for universities:

> *"Higher education cannot change easily. Traditions, values, infrastructure all create the conditions for a natural inertia. It is being forced to change, and the pressures wrought upon it have nothing to do with traditions and values. Instead the pressure is for reduced costs, for greater scale and scope, and for innovation through technology."* (2002, p. 3)

Figure 1: Stata Center, MIT.
Architect: Frank Gehry
Source: Author.

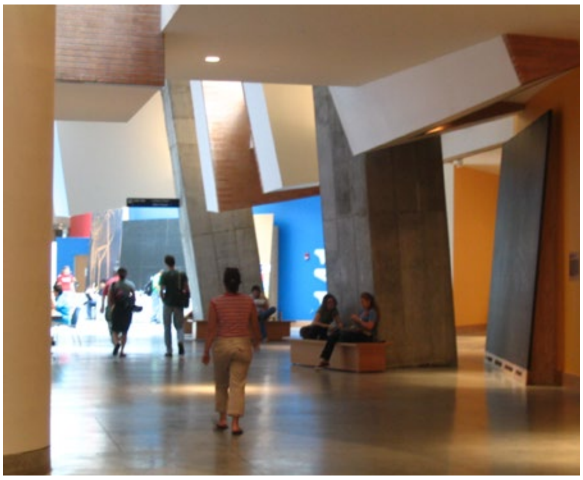


Figure 2: Stata Center Concourse, MIT.
Architect: Frank Gehry.
Source: Author.

Figure 3: Stata Center remnants of ideas, MIT.
Architect: Frank Gehry.
Source: Author.

Figure 4: Stata Center Lecture Hall, MIT.
Architect: Frank Gehry.
Source: Author.

Historically, pedagogical practice across all sectors of education has been teacher centred. The teacher controlled or directed what and how it was to be learned, and then tested the student to determine how much had been learned. Teaching was commonly considered a process involving a teacher possessing greater knowledge than the students, 'delivering' new knowledge for students to receive. The implication for the design of classrooms was to place the teacher at the 'front' and for all students to sit facing the teacher. Further, the implication of this type of classroom setting for student behaviour was that students would sit and listen, occasionally encouraged to ask questions or engage with their peers.

The first indicators of change in thinking about teaching and learning practice emerged in schools around the turn of the 20th century with the Progressive Education movement. Led by the renowned philosopher, John Dewey, this movement aimed to invert the teacher focus by placing the student at the centre of their learning experience and for learning to be embedded in real-life scenarios (Dewey, 1897, 1961). These ideas gradually informed a transformation towards a more student-centred pedagogy, which is evident in many primary schools across the world. Although its implementation has varied widely internationally and within Australia, student-centred learning represents a view of the teaching and learning process that prioritises student understanding and what the student does to learn.

The early 20th century heralded the emergence of research into how children learn, which led to the theory of constructivism as developed by Jean Piaget and Lev Vygotsky (Pass, 2004; Piaget & Inhelder, 1969; Vygotsky, 1978). Constructivism refers to learning as a process of constructing knowledge through interactions between the child's experiences and ideas. It effectively provides a link between the notion of student-centred learning that began with the Progressive Education movement of the early 20th century, located in schools, and research into student learning in higher education that emerged from the Gothenburg Group in the 1970s (Marton & Saljo, 1976a). The discourse that emerged around student learning in universities led to a better understanding of the differing approaches, motivations, perceptions of the learning task and effect of prior learning experiences (Entwistle, 1984; Marton & Saljo, 1997).

This student learning research revealed the ways in which students construct and retain knowledge through interaction with peers and by engaging in activities that reinforce theory and concepts—applications that strongly resonate with the theory of constructivism. Marton and Saljo (1997) articulate the process of engaged learning processes as enabling students to attain a 'deep' level of understanding. They also identify a ‘surface’ approach to learning, adopted by students who typically focus on information and facts rather than a deeper understanding of concepts. Further, Marton and Saljo (1997) and Entwistle (1984) assert that didactic learning experiences, represented in lectures and often tutorials, encourage students to adopt a surface approach to learning. Student learning research therefore heralded a significant shift in higher education from teacher-centred to student-centred learning, and provided a fundamental sense of what constituted effective teaching and learning processes in higher education.

The term ‘effective teaching and learning’ emerged in the literature to capture the aspiration to improve both the process and the outcome of pedagogical practice without imposing a singular method or technique (Prosser & Trigwell, 1999; Ramsden, 1992; Skinner, 2010). Importantly, it distinguished between the pedagogical context and the roles of the teacher and student, especially the leading role of the teacher in undergraduate programs (Prosser & Trigwell, 1999). This discourse describes the approach adopted by the teacher and applied in practice, to establish the optimum conditions that enable student learning to occur (Ramsden, 2003). It acknowledges the deliberation by the teacher to plan, anticipate, implement, evaluate and assess student learning activities, while recognising student prior learning and the unique perspectives that students bring to the learning encounter (Biggs, 2003; Prosser & Trigwell, 1999). The effective teaching and learning discourse is primarily concerned with a student-centred pedagogy that aims to engender a deep approach to learning in students (Marton, Hounsell & Entwistle, 1997).

As a result of an interrogation of the term ‘effective teaching and learning’ in the literature on student-centred learning in higher education, six common characteristics were identified as representing the essence of effective teaching and learning. These ‘Essential Elements of Effective Teaching and Learning’ (refer Table 1) provide a theoretical framework that underpins the two unique contributions to knowledge emanating from this study.

Drawing upon these theoretical foundations, and more broadly research into student learning, a range of innovative pedagogies has emerged that stand in stark contrast to the traditional didactic lecture and tutorial model. What they share is a concern to shift focus from the teacher and teaching, to the student and learning. Consequently, the higher education landscape has been enriched by the introduction of more explicitly student-centred pedagogies including ‘problem-based learning’ (Boud & Feletti, 1997; Savin-Baden & Major, 2004), ‘project-based learning’ (Boss,2014; Ho & Brooke, 2017) ‘collaborative learning’ (Bruffee, 1999; Garrison & Archer, 2000) and ‘peer learning’ (Cohen, Sampson & Boud, 2001; O’Donnell & King, 1999).

Table 1

Essential Elements of Effective Teaching and Learning

Effective teaching and learning in higher education classrooms...	References:
1. encourages the teacher to understand the student's perspective and build meaningful relationships with students	Entwistle, 2009; Laurillard, 2002; Marton & Booth, 1997; Prosser & Trigwell, 1999; Ramsden, 2003; Rogers, 1969
2. is a social process whereby knowledge is socially constructed	Dewey, 1897, 1961; Garrison & Archer, 2000; Laurillard, 2002; Lave & Wenger, 1991; Piaget & Inhelder, 1969; Vygotsky, 1978
3. fosters a deep approach to learning that encourages student independence	Dewey, 1961; Entwistle, 1984; Hounsell, 1997; Marton & Saljo, 1997; Rogers, 1969
4. promotes student activity and engagement with content	Biggs & Tang, 2007; Chickering & Gamson, 1987; Entwistle, 2009; Hounsell, 1997; Prosser & Trigwell, 1999; Ramsden, 2003; Shuell, 1986; Skinner, 2010
5. is contextualised & relevant; teachers have an awareness of student prior learning	Biggs & Tang, 2007; Entwistle, 2009; Hounsell, 1997; Laurillard, 2002; Prosser & Trigwell, 1999; Ramsden, 2003; Rogers, 1969; Shuell, 1986; Skinner, 2010
6. involves the teacher providing effective and timely feedback to students	Biggs & Tang, 2007; Chickering & Gamson, 1987; Entwistle, 2009; Hounsell, 1997; Laurillard, 2002; Prosser & Trigwell, 1999; Ramsden, 2003

1.1 PEDAGOGY AND SPACE

1.1.1 The Paradox of Theory and Practice

The discourse on 'student learning' in higher education, which informs this study, emerged against the backdrop of a university campus environment and particularly its classrooms, which had largely remained unchanged over decades and possibly centuries. The student learning discourse is the product of a multitude of theoretical tracts and research studies undertaken in, and reflecting on, a wide variety of national educational systems, institutional types and disciplinary fields (Dewey, 1961; Marton, Hounsell & Entwistle, 1984; Marton & Saljo, 1976a; Ramsden, 1992; Vygotsky, 1978). In fundamental ways it has reshaped our understanding of the relationship between teaching and learning and what it means to learn in the university context (Noel Entwistle, 2009; Laurillard, 2002; Prosser & Trigwell, 1999; Ramsden, 1992). Paradoxically, despite its methodological and epistemological rigour, the student learning discourse fundamentally presents us with a view of the teaching and learning process that is removed from any relationship to the physical environment in which it occurs.

Essentially there is no explicit link between the theory of teaching and learning in higher education as presented in student learning research and the physical environment in which teaching and learning takes place. For instance, what effect does the extant classroom space—its size, shape, configuration, furniture—have on the teacher's view of what form of teaching is possible in that setting? There is rarely any suggestion as to how physical conditions may influence the teacher's lesson plan or the learning activities and behaviours afforded by the physical environment. Further, many of the leading proponents of the student-centred learning discourse introduce a uniquely institutional notion of 'environment' that has no explicit physical dimension (Biggs, 2003; Laurillard, 2002; Prosser & Trigwell, 1999). For example, Laurillard proposes a concept of the 'environment' as the sum of the circumstances in which teaching and learning occurs, stating:

> *"teaching is essentially a rhetorical activity, seeking to persuade students to change the way they experience the world through an understanding of the insights of others. It has to create the environment that enables students to embrace the twin poles of experiential and formal knowledge."* (2002, p. 23)

Similarly, Biggs states that "the teacher simply acts as broker between the student and a learning environment that supports the appropriate learning activities" (2003, p. 27), in the context of an institutional system that "comprises all things in and out of the classroom" (2003, p. 19).

In these and other examples, the term 'environment' evokes a very broad, non-spatial meaning and refers to the numerous, though often intangible conditions, that surround students and teachers, yet influence the teaching and learning process. It is a catch-all phrase to embrace those other factors not specifically of concern to the researchers and their focus on 'teaching' or 'learning'. Lacking any precise description in the discourse, we are left to assume that the environment consists of anything from the administrative organisation of a subject to the timetable, a student's prior learning experience, the composition of the student cohort, the online learning environment, the academic or disciplinary culture and the individual student's motivation to learn.

The discord between student learning research and the physical environment is further contradicted by the environmental psychology literature, which has paralleled student learning research over the last 50 years. The environmental psychology discourse emerged in the late 1960s, culminating in the seminal text, *Environmental Psychology: Man and His Physical Setting* by Proshansky, Ittelson and Rivlin (1970), who boldly assert that human behaviour is influenced by the physical environment. They declare:

> *"The physical environment that man constructs is as much a social phenomenon as it is a physical one. Man's constructed world, whether it is a school, hospital, apartment, community or highway, is simply an expression of the social system that generally determines his activities and his relationships with others ... Spaces, their properties, the people in them, and the activities that involve these people represent significant systems for the individual participant and thereby influence his responses to the physical setting."* (Proshansky et al., 1970, pp. 8–9)

More recently, architect Bryan Lawson describes the physical environment as having an intrinsic 'language' that affects how people relate to each other through proxemics, perception, distance and time (2001). He says:

> *"Space is both that which brings us together and simultaneously that which separates us from each other. The human language of space, whilst it has its cultural variations, can be observed all over the world wherever and whenever people come together. Architecture organises and structures space*

for us, and its interiors and the objects enclosing and inhabiting its rooms can facilitate or inhibit our activities by the way they use this language." (Lawson, 2001, p. 6)

Similarly, in defining environmental psychology, Robert Gifford concludes "individuals change the environment and their behaviour and experiences are changed by the environment" (2002, p. 1). Environmental psychology research relates environmental concepts such as volume, light, texture, furniture and way finding as designed elements that will affect the activities that are enabled in those spaces (Gifford, 2002; Lawson, 2001; Proshansky et al., 1970). The discourse also discusses space in terms of its 'affordances', a term that Gifford attributed to James Gibson, relating to the "instantly detectable functions" and our perception of spatial elements that provide clues as to "what the place can do for us" (Gifford, 2002 p. 29–30).

If the physical environment influences human behaviour, as the environmental psychology discourse has established, then it follows logically that the design of all learning environments—but particularly formal classrooms from the perspective of this study—will express explicit intentions and expectations regarding the teaching and learning process. Curiously, the environmental psychology discourse itself has given very little attention to educational settings and the pedagogy–place nexus. There are few references to learning environments in the expansive literature that addresses a wide range of physical environments from cafes to hospitals, and from workplaces to public spaces. Where some correlation between learning environments and behaviour is identified, it is contextualised on the effect of acoustics, lighting and colour on learning (Gifford, 2002), rather than learning behaviours in relation to teaching and learning theory. A rare number of case studies that do link pedagogy and human behaviour are presented in Chapter 2.

Despite the obvious potential theoretical and practical conjunction of the fields of environmental psychology and student learning research, they have remained largely disconnected. This research is situated at the point where these two distinct intellectual discourses should necessarily coalesce to advance the theory, and practical development, of appropriate formal and informal learning environments to promote effective student-centred learning.

1.1.2 The Emergence of a New Generation of Learning Spaces

Efforts to introduce student-centred pedagogies struck a major obstacle in universities nationally and internationally. If, as this study proposes, the physical environment is integral to the experience and process of teaching and learning, it follows that student-centred pedagogies in higher education will require very different physical environments—environments that motivate, enable and empower students to learn.

Around the turn of the 21st century, a small number of practitioners in the United States of America (USA) and Australia designed and activated university classrooms and informal learning environments explicitly intended to implement student-centred learning. The proponents of these projects contended that traditional teaching spaces impeded more active student-centred approaches, which led them to explore alternative settings for learning environments in higher education. In challenging the physical form and function of traditional classrooms, a small number of experimental spaces were designed to enable teachers to facilitate collaboration, interactivity and active learning and ultimately to enhance the student learning experience. The experience and observations of these early examples were published in research papers that included descriptions of positive student feedback as well as a sense of increased student engagement in the classroom (Carbone & Sheard, 2003; Jamieson, Fisher, Gilding, Taylor & Trevitt, 2000; Trevitt, 1999; Wolff, 2002).

As evidence mounted that alternative spatial configurations of teaching spaces were yielding positive responses from students and teachers, the design of alternative learning environments became a topic of growing interest among university leaders. Universities initially experimented with singular spaces and different furniture arrangements but by the mid-2000s, a number of institutions had boldly invested in new classroom and informal learning infrastructure, often embracing new educational technologies. In so doing, these pioneering universities were asking critical questions about the role of the teacher, the role of the learner and the physical environments in which teaching and learning takes place.

This study is about the emergence of a new typology of learning environment designed to facilitate pedagogies that are primarily aligned, at the broadest level, with higher education's shift towards 'student-centred learning', expressed in practices such as collaborative learning, PBL and peer-to-peer learning. The current study describes this alternative typology as a 'new generation learning environment', defined by the author as **a single space or suite of settings designed to improve teaching and learning through the provision of physical environments that will enable more student-centred teaching and learning processes**.

1.2 THE PRIMARY FOCUS OF THE STUDY

This study addresses the emergence of NGLEs in higher education, as a unique classroom typology to support and enable student-centred learning. What was the catalyst for developing a new classroom typology? Who were the protagonists? Why was a new classroom typology deemed necessary? What physical characteristics of NGLEs were designed to specifically support student-centred learning? In responding to these and other questions, the author has drawn upon research and case studies from the fields of education and environmental psychology to examine the behaviours associated with student-centred learning and evaluate four case study examples of new generation learning environments. As such, the primary research question for this study is: **How have new generation learning environments in higher education been conceptualised pedagogically, and designed physically, to enable effective teaching and learning?**

Each case study has been selected on the basis of meeting the definition of a new generation learning environment, and simultaneously demonstrating variety in application of the definition. Each of the case study NGLEs was initiated by academics who intended to implement a specific student-centred pedagogical approach, primarily a form of collaborative learning. The evaluation method for each case study included in situ observations of timetabled classes, interviews with teachers prior to the observed class (to understand teaching & learning intentions), interviews with the architects of each NGLE (to document their understanding of the teaching and learning behaviours to be enabled) and interviews with various other stakeholders who impacted the design and/or operations of the NGLEs.

The term 'effective teaching and learning' has been examined within the context of the discourse on student-centred learning, which argues for students to be active participants in their learning experience and advocates for students to interact and collaborate with peers, especially in the classroom environment. Effective teaching and learning also refers to the teacher's approach to teaching, including their intention to implement student-centred pedagogies such as collaborative learning, problem-based learning and peer learning. It is fundamental to the effectiveness of NGLEs however, that the teacher brings an educational intention to adopt a student-centred learning approach to teaching and learning.

By analysing the effective teaching and learning discourse it is possible to synthesise the relational behaviours of teachers and students, that exemplify effective teaching and learning. Further analysis of the effective teaching and learning behaviours leads to identification of the spatial characteristics that support the effective teaching and learning process, culminating in the Effective Teaching and Learning Spatial Framework.

The Effective Teaching and Learning Spatial Framework has been adopted as a lens through which to evaluate the case study examples of NGLEs. It provides a framework for examining the physical classroom features and characteristics that enhance the possibility for effective teaching and learning behaviours taking place. A comparative analysis of the case studies led to the identification of six spatial characteristics that epitomise a NGLE, with the contention that the design of future NGLEs should incorporate each of the six spatial characteristics.

Evaluation of NGLEs is considered a valuable action, in order to validate NGLEs as a vital addition to university campus space typologies. The Effective Teaching and Learning Spatial Framework is able to be adapted to a series of ‘possibility statements’, providing the foundation for the Effective Teaching and Learning Evaluation Tool. The Evaluation Tool is applied to the case study NGLEs as well as tested on a range of recently designed NGLEs.

Therefore, as a result of the observations and interviews relating to the four case study NGLEs, the unique contribution to knowledge is demonstrated through the development of two schemas: 1) The Effective Teaching and Learning Spatial Framework (a theoretical construct); and 2) The Effective Teaching and Learning Evaluation Tool (a practical evaluation process). The Effective Teaching and Learning Spatial Framework unites the essential characteristics of effective teaching and learning with relational learning behaviours, resulting in a range of spatial characteristics that are representative of NGLEs. The Effective Teaching and Learning Evaluation Tool enables evaluation of the possibility of effective teaching and learning behaviours to be enacted in any formal classroom environment.

1.2.1 The Structure of this Thesis

The remainder of this thesis adopts the following structure:

Chapter 2: Literature Review

This chapter positions the study across the fields of ‘education’ and ‘environmental psychology’ and is presented in three parts: Part 1 outlines the evolution of student-centred learning in higher education, highlighting a gap within the ‘student learning’ discourse: a lack of awareness of the integral role that the physical environment plays in the teaching and learning process. This section also outlines the practice of student-centred pedagogies such as collaborative learning, problem-based learning and peer learning, as critical context to the case study evaluations. Part 2 details the theoretical and practical insights offered by the environmental psychology discourse, in particular the contention that human behaviour is impacted by the physical environment. Part 3 outlines early examples of NGLEs that contributed to the establishment of an entirely new space typology on university campuses and the evaluation processes that have informed their ongoing development.

Chapter 3: The Effective Teaching and Learning Spatial Framework

The theoretical framework for this study is presented in detail, revealing the unique conjuncture of education theory and environmental psychology. The lens of 'effective teaching and learning' is used to identify effective teaching and learning behaviours to be enabled in a NGLE.

Chapter 4: Methodology

The methodological context for this research is centred on the case study analysis. This chapter explains selection of the four NGLEs, including development and testing of the evaluation methodology on a pilot case study. Each evaluation was based upon the concept of interviewing a teacher to understand their pedagogical intention for the timetabled learning encounter that was subsequently observed by the author in the NGLE. This chapter also explains the challenge of evaluating the Victoria University Electrical Engineering PBL Studios and the adaptation to an alternative evaluation method.

Chapters 5–8: Case Studies

Chapters 5-8 report upon four selected case studies located at four Australian universities. Each case study was selected on the basis of being identified as early examples of NGLEs. Two of the four case studies were presented at a TEFMA workshop at the University of Queensland in 2005, representing one of the first Australian forums for discussing the emergence of NGLEs (Fisher, 2005). The third case study (The Learning Lab) was completed in 2007, although the evaluation was undertaken in 2008 to ensure teachers had time to adjust to the new space. The fourth case study (Victoria University School of Electrical Engineering PBL Studios) was brought to the author's attention as a result of being invited to the opening of the new facility.

Chapter 5 describes the pilot case study, the Deakin Immersive Learning Environment (DILE) at Deakin University's Burwood campus. Chapter 6 presents the Collaborative Teaching and Learning Centre (CTLC) at the St. Lucia campus of the University of Queensland. Chapter 7 focuses on the Learning Lab at the

University of Melbourne and Chapter 8 reports on the PBL precinct for the School of Electrical Engineering at Victoria University's Footscray campus.

Chapter 9: Case Study Analyses and Discussion

Each of the case studies are collectively analysed within the context of effective teaching and learning behaviours observed or identified as being possible in the NGLEs. This included the identification of six spatial characteristics that culminate in the Effective Teaching and Learning Spatial Framework.

Chapter 10: The Effective Teaching and Learning Evaluation Tool

As a result of further dissection of the teaching and learning behaviours embedded within the Effective Teaching and Learning Spatial Framework, and in response to the challenges of evaluating new generation learning environments, a simple and effective evaluation method emerged. This chapter describes the evolution of the Effective Teaching and Learning Spatial Framework into the Effective Teaching and Learning Evaluation Tool. Based on 25 statements that correspond to the pedagogical possibilities of a NGLE, the Evaluation Tool can be completed post-occupancy by students, teachers and other stakeholders. The chapter also describes the Tool's versatility as a design tool and/or teaching prompt.

Chapter 11: Conclusion

The final chapter outlines the evolution of NGLEs completed subsequent to the case study examples presented in chapters 5 – 8, and the establishment of NGLEs as an accepted space typology on Australian university campuses. The Effective Teaching and Learning Evaluation Tool is applied to a range of recent NGLE examples, culminating in a revision of the spatial characteristics in the Effective Teaching and Learning Spatial Framework.

Chapter 2: Literature Review

2.0 INTRODUCTION

Chapter one described the emergence of a new classroom typology in higher education, referred to in this study as a New Generation Learning Environments (NGLE). They have been developed intentionally to enable and promote student-centred learning as a conscious effort to challenge historically established didactic pedagogies conducted in lecture theatres and tutorial/seminar classrooms. The pedagogical and design intentions embedded in the development of NGLEs have been influenced not only by an educational understanding of student-centred teaching and learning practice, but with an understanding that the physical classroom environment can influence the behaviour of teachers and students.

This chapter will detail two distinct yet complementary fields of knowledge, as introduced in chapter one: Firstly, student learning research in higher education, and secondly, environmental psychology, being the study of human behaviour in the built environment. Additionally, this chapter will acknowledge a new discourse on the development of NGLEs. Therefore, chapter two will be presented in three parts.

Part 1 presents the existent tensions between traditional forms of teaching in higher education and the development of student-centred learning. Student learning research proclaims the benefits of learning within a social and collaborative context, contending that student-centred learning leads to deeper understanding of concepts and increased engagement in class (Entwistle, 2009; Ramsden, 2003). Despite the positive aspirations for student-centred learning, a gap in the field is revealed whereby research into how students learn is abstracted from the physical situation in which student-centred learning takes place. A review of student-centred practice extracts teaching and learning behaviours that present implications for the design of classrooms to support student-centred learning.

Part 2 focuses on literature relating to the highly contested field of environmental psychology, taking the position that the physical environment does influence human behaviour. The review reports on a small quantum of studies that have focused on human behaviour and the settings in which learning occurs, presenting a critical backdrop to the case studies evaluated in this study.

Part 3 presents a review of literature pertaining to the emergence and development of NGLEs, a field of research that is positioned, in the context of this study, at the conjunction of student-centred learning research and environmental psychology. Early examples are detailed, followed by an analysis of post occupancy evaluation methodologies that aim to garner institutional support for ongoing investment into NGLEs.

2.0.1 Exclusions from this Study

Before expanding upon the literature shaping this exegesis, it is important to acknowledge the related topics that are not the focus of this study. These include online and distance learning, 'blended learning', informal learning spaces and educational technology.

Online learning and distance learning are two distinct and separate fields of study in which pedagogical theory may overlap. Students undertaking online or distance learning will have an inherently different experience of learning compared to students who are situated on campus. For example, a student who studies in the library with access to physical books and a librarian is differentiated from a student with access to digital library resources and a chat room where a librarian can offer support. With online learning, students and teachers transact across digital platforms without needing to meet face to face, although they may communicate frequently. This study acknowledges the unique learning experience afforded by online and distance learning and the existent research in the field (Baxter, Callaghan & McAvoy, 2018; Bender, 2012; Palloff, 2005).

In the 21st century it is customary for higher education students to experience university as a 'blended experience', defined by Keppell & Riddle as "the integration of both on-campus face-to-face learning and teaching and on or off-campus virtual learning environments utilising the affordances of each environment to enhance the student experience" (2012, p. 9). Keppell & Riddle acknowledge the criticality of both the physical and virtual environments as enablers of learning, further asserting that "a combination of physical/virtual, formal/informal would be considered in these spaces to optimise the student experience" (2012, p. 9). This has resulted in higher education teachers transitioning their teaching practice from an explicitly physical setting to incorporating new educational technologies, communication techniques and workflow in an online platform. Dominant researchers in the field of 'blended learning pedagogy' include Garrison & Kanuka (2004), Graham, Woodfield & Harrison (2012) and Halverson, Graham, Spring, Drysdale & Henrie (2014).

Over the last twenty years, informal learning spaces have increasingly become a vital addition to the campus learning space typology. They have risen to prominence for a number of reasons, such as improving the on-campus experience and as a response to increased engagement in collaborative learning, demanding places for students to study together beyond the formal classroom (Harrop & Turpin, 2013; Jamieson, 2009; Keppell & Riddle, 2012). In many ways it is difficult to explore the effect of the formal classroom environment without also addressing the student experience of informal learning spaces. However, learning in informal campus-based environments requires deeper exploration of social behaviour, social cognitive processes and generational attributes—foci that are beyond the scope of this study.

Educational technology comprises another differentiated field of research that is related to but not the focus of this study. The pedagogy of educational technology is extensive and rapidly developing as new technologies emerge (Davies, Dean & Ball, 2013; Hokanson, 2015; Voogt, Fisser, Pareja Roblin, Tondeur & Van Braak, 2013). A common characteristic of NGLEs is that students have access to technology systems during formal class time, a classroom experience not typically available to students in traditional learning spaces. While educational technology is addressed in this study in terms of the transactional experience between the student and the physical environment, educational theory influencing the use of educational technologies is not addressed. This study firmly focuses on the spatial characteristics of NGLEs including access to educational technologies that enable student-centred learning to effectively take place.

2.1 PART 1: STUDENT-CENTRED LEARNING

2.1.1 Lectures: A Critique

For centuries, teaching in higher education has remained dogmatically organised around lectures and tutorials, representing a conception of teaching that is fundamentally teacher centred (refer Figures 5- 8). The underlying premise of the lecture and tutorial lies in a very particular conception of the teacher–student relationship. From this perspective, it is the teacher who is recognised as the expert, as the presenter of knowledge in the form of a lecture to a cohort of students. In turn, the students are expected to 'receive' or 'consume' knowledge before reproducing content in response to formal assessment tasks. This emphasis on the teacher as the transmitter of knowledge has perpetuated a focus on teaching rather than learning, bolstering the repetition of this didactic teaching mode. Therefore, before reviewing the literature on student-centred learning it is first essential to critically comment on research relating to the effectiveness of learning in lectures.

There have been numerous studies focusing on best lecturing practice, including methods for retaining student engagement with the content topic (Brown & Race, 2002; Gibbs, Habeshaw & Habeshaw, 1988; Svinicki & McKeachie, 2011). However, these types of publications do not challenge the pedagogical efficacy of lecturing, assuming the position that lecturing has and will continue to be the dominant university teaching experience. Where research into the effectiveness of lecturing as a mode of learning has been undertaken, the results are conflicting and contradictory.

In one of the most oft-cited publications on the lecture method, educator Donald Bligh (1972) conducted an extensive review of literature and studies conducted on the topic of lecturing during the early to mid-20th century. He concluded that lectures can potentially achieve three key objectives. Firstly, the acquisition of information; secondly, the promotion of thought; and thirdly, changes in attitude. Bligh casts doubt on the adequacy of lecturing as an effective model of learning, concluding that "the evidence suggests that [lectures] can only effectively achieve one [objective]—the student's acquisition of information" (Bligh, 1972, p. 49).

Bligh's conclusions on the limitations of lectures appear to be supported by Wilbert McKeachie, who, in the 13th edition of the seminal text *McKeachie's Teaching Tips*, promotes lecturing as a positive teaching model, yet simultaneously concludes that "discussion, however, is likely to be more effective than lecturing in

Figure 5: Remains of Lecture Hall, University of Alexandria, circa 5th Century (Majcherek, 2008).

Figure 6: Lecture at the University of Bologna, circa 1300s (Olmert, 2003).

Figure 7: Lecture at the University of Pennsylvania School of Medicine (1888).
Source: Alamy Image ID K6YA3E

Figure 8: Lecture in the 21st Century.
Source: Author.

achieving higher-level cognitive and attitudinal objectives" (Svinicki & McKeachie, 2011, p. 71).

Karen Wilson and James Korn (2007), who undertook a study into the length of student attention during lectures, also support Bligh's proposition regarding the purpose and objectives of lectures. They state:

> *"If the purpose is solely to transmit information, then lecturing can be an effective method, and it would behove instructors to follow the suggestions of the many books on teaching. However, if the objective is critical thinking, then teachers probably should be doing more than just lecturing."* (Wilson & Korn, 2007, p. 88)

Numerous publications have dedicated effort to both criticising and promoting lectures, with an emphasis on improving the skills of teachers to make lectures more engaging (Brown and Race, 2002; Carbone, 1998; Gibbs, Habeshaw & Habeshaw, 1988). Haynes & Habeshaw (2012) present *53 Interesting Things to Do in Your Lectures*, which provides suggestions for student activities that may be facilitated during a lecture. Their suggestions include collaborative activities such as 'pyramids' (where students first work on their own, then in a pair and then within a group of four students), 'tiers' (where students use the structure of the tiered lecture theatre to form discussion groups) and 'debates'. Haynes & Habeshaw state that "students seldom learn what you are lecturing about while they are still in the lecture room", reinforcing the benefit of enabling students to apply learning through activities during lectures (2012, p. 39).

While some exponents of the lecture method have suggested ways of increasing student activity during lectures, as described above, the tiered structure of lecture theatres or high density seating arrangement often limits the potential to implement student activities.

Irrespective of the literature on the effectiveness (or otherwise) of the lecture as a mode of teaching, the practical reality in many universities worldwide is that university life is organised around lectures. Courses and timetables are structured around them; campuses are constructed to facilitate them; and academics are paid to deliver them. Educator Diana Laurillard confronts the prevailing orthodoxy of the lecture's predominance as the primary mode of teaching:

> *"If we forget the eight hundred years of university tradition that legitimises [lectures], and imagine starting afresh with the problem of how best to enable a large percentage of the population to understand difficult and complex ideas, I doubt that lectures will immediately spring to mind as the obvious solution."* (2002, p. 93)

Laurillard instead proposes alternative modes of learning that encourage greater interactivity between students and, where appropriate, the utilisation of educational media (2002).

Education theorist Paul Ramsden articulates a realistic perspective on why lectures continue to dominate the higher education learning experience:

> *"Lecturing remains the pre-eminent method of teaching in most subjects in on-campus institutions. The majority of university teachers still seem to favour it; many timetables are organised around it; lecturers will argue that students, especially first year students, are unable to learn without it; numerous books have attempted to justify it, to improve it, to change it. Arguments against lecturing are likely to meet the same withering replies that other arguments which cut across tradition in higher education meet; it is not realistic to abandon or even substantially modify it; it is not economical to change it; it might reduce standards if we tamper with it."* (Ramsden, 2003, p. 147)

Notwithstanding the dominance of the lecture format and its questionable efficacy as a learning modality, a contrasting conception of the teaching and learning process has emerged over the last century. This alternative conception of teaching and learning places greater emphasis on 'learning' and the student's role in the process, rather than focusing on 'teaching' and what the teacher does, an approach to learning broadly labelled student-centred learning. The next section will outline the origins of student-centred learning and its development in higher education.

2.1.2 The Origins of Student-centred Learning in Schools

The Progressive Education movement of the late 19th and early 20th centuries represented a radical paradigmatic shift in its unreserved emphasis on the students and the context of learning in schools. Led by renowned philosopher John Dewey, the central tenet of Progressive Education was democratising the child to experience education in real-life contexts; "a process for living and not a preparation for future living" (1897, p. 13). Dewey is considered the founding father of what is recognised today as student-centred learning. He was one of the first people to admonish a (universal) education system that assumed teachers were the only people capable of filling children's heads with knowledge, establishing a "dependency of one mind upon another" (Dewey, 1915, p. 32).

Dewey presented one of the first comprehensible accounts of the capacity of children to contribute to their learning experience through activity and dialogue. He believed not only that the social process of learning in the classroom enables children to make sense of content through language that they understand, but more importantly, that this social process shapes the child's character in preparation for a "proper social life" (Dewey, 1897, p. 80). Dewey explained:

> *"I believe that the school is primarily a social institution. Education being a social process, the school is simply that form of community life in which all those agencies are concentrated that will be most effective in bringing the child to share in the inherited resources of the race, and to use his own powers for social ends."* (1897, p. 78)

Dewey rejected the accepted notion of the time, that a child's primary source of learning was through an isolated transaction with the teacher, believing that the child's capacity to learn is enhanced through their interaction with other children. This 'social process' of learning was a fundamental concept in what later became known as the theory of constructivism, an educational approach founded upon children learning from each other through activity and interaction.

Constructivism presents a conception of teaching that is student-centred, active, social and collaborative, representing a distinct departure from the teacher-centred practice that was, until the early 20th century, the accepted pedagogical paradigm in schools. The theory of constructivism is widely attributed to Lev Vygotsky (1978) and Jean Piaget (Paiget & Inhelder, 1969) during the early 20th century; their ideas reflecting an affinity with Dewey's philosophies. Constructivism initially described an approach to learning that enabled children to develop meaning and understanding—to construct knowledge—through discussion and activity, but these same concepts have subsequently resonated with student learning in higher education, as this section will expand upon. Foundational exponents of constructivism share a belief that learning should be enquiry-based, activity-centred and contextualised within an environment appropriate to the student's cognitive development (Montessori, 1989; Pass, 2004; Piaget & Inhelder, 1969; Vygotsky, 1978). Vygotsky proclaims that:

> *"Learning awakens a variety of internal development processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers. Once these processes are internalised, they become part of the child's independent developmental achievement."* (1978, p. 90)

Prior to constructivism being applied in classroom settings, children experienced school as a series of spatially confined rooms with individual desks rigidly arranged in rows and columns, a setting designed to inhibit interaction between children and enable them to focus primarily on the commanding figure of the teacher (see Figure 9). In contrast, many contemporary school classrooms—particularly in primary schools—now reflect the critical ideas of constructivist theories within their design. Rather than sitting in rows and columns of desks, children sit around tables facing each other to enable greater interaction with each other (see Figure 10).

Through a transformation of the 'idea' of the classroom these spaces have been designed as lively, dynamic, interactive, colourful and, when appropriate, noisy environments in which children can interact with each other through discussion and cooperative activity to construct meaning and understanding. The principles of constructivism have had a profound effect on schools by transforming the classroom experience from a didactic teacher-centred experience to a student-centred environment. This is reflected in the physical environment, with student-centred classrooms incorporating furniture that enabled interaction, activity and the social construction of knowledge.

Figure 9: Photo of Group of children and teacher in the classroom (1932).
Source: 123RF Stock Photo

Figure 10: Photo of Empty Classroom
Source: Getty Images, Credit: DGLimages

2.1.3 Student Learning Research in Higher Education

"The aim of teaching is simple: it is to make student learning possible" (Ramsden, 2003, p. 7).

Paul Ramsden's quote reminds the reader that teaching is a means for student learning, not the outcome. The ability of the teacher to lecture does not guarantee that learning occurs, unless students are engaged to deeply understand concepts, context and content. Ramsden's concept of learning represents a distinct shift in the approach to teaching, an approach that began to change through the emergence of research into student learning in higher education.

During the 1970s a body of research emanated from a group of educators at Gothenburg University in Sweden, who became known as the Gothenburg Group. Their research represents the most sustained, intense effort to understand how university students undertake the process of learning (Entwistle, 1984; Hounsell, 1984; Marton & Saljo, 1976a, 1976b). Ference Marton and Roger Saljo's seminal paper (1976a) provides the foundation for many subsequent research projects that have sought to better understand the process of student learning as a means of improving the quality of teaching. This unique discourse became known as 'student learning research'.

Marton and Saljo's major contribution to 'student learning research' is the revelation that students approach the process of learning in qualitatively different ways, depending on their perception of the task and how it will be assessed (Marton & Saljo, 1976a). Marton and Saljo examined how students fulfil the task of reading a body of text for the purpose of subsequently being tested with questions. The study sought to identify how students organise the subject matter of the text to gain understanding, revealing what Marton and Saljo call "an astonishingly simple picture" (Entwistle, 1984, p. 18). They define student responses as falling into one of three categories relating to the approach to the task, namely deep, strategic and surface. These approaches are defined in the table, Approaches to Learning, adapted from Entwistle (see Table 2). Ramsden describes this 'approach to learning' as "one of the most influential concepts to have emerged from research into teaching and learning in higher education during the last twenty five years" (Entwistle, 2003, p. 40).

Table 2

Approaches to Learning, adapted from Entwistle (1984)

Deep Approach	**Intention to understand ideas for yourself by:**
	Relating ideas to previous knowledge and experience
	Examining logic and argument cautiously and critically
	Becoming actively interested in the course content
Strategic Approach	**To achieve the highest possible grades by:**
	Putting consistent effort into studying
	Finding the right conditions and materials for studying
	Being alert to assessment requirements and criteria
Surface Approach	**Intention to cope with course requirements by:**
	Study without reflecting on either purpose or strategy
	Memorising facts and procedures routinely
	Finding difficulty in making sense of new ideas presented

As researchers began to investigate how university students learn, parallels with constructivism began to emerge (Biggs, 2003; Marton et al., 1984; Prosser & Trigwell, 1999; Ramsden, 2003). Notably, in 1984 Noel Entwistle, one of the foundational theorists of student learning in higher education, acknowledges that "constructivism has recently become widely accepted within education" (1984, p. 9).

Another seminal figure in the higher education discourse on student learning, educational psychologist John Biggs (2003), discusses constructivism as a means of emphasising what students do to enhance learning, citing Piaget as a "crucial figure" in constructivist theory (p. 12). Constructivism is an integral element in Biggs's (1999, 2003) theory of 'constructive alignment', as is Randy Garrison and Walter Archer's (2000) concept of 'transactional teaching and learning'. Graham Gibbs and Trevor Habeshaw (1996) reveal their debt to constructivism (though without direct reference to it) by describing optimal conditions for learning as enabling students to construct knowledge, 'learning by doing' and learning in small groups. Bruce Marlow and Marilyn Page (2005) explicitly relate constructivism to teaching and learning practice, describing its application as encouraging students to actively think, analyse, understand and apply, as opposed to 'traditional' teaching methods that promote accumulation, memorisation, repetition and general passivity.

Importantly for this study, the notion of the active student is a critical concept as it lays the foundation for the design of classroom environments to explicitly enable student activity. It is a contention of this study that classrooms designed for active learning demand an entirely different spatial consequence from the traditional mono-directional arrangement in lecture theatres and tutorial rooms. Instead, the design of classrooms for student-centred learning should be aligned with the anticipated activities and behaviours associated with more active learning processes.

2.1.4 Effective Teaching and Learning

The concept of student-centred learning is variously presented throughout the discourse as 'good' or 'effective' teaching practice (O'Neill & McMahon, 2005; Prosser & Trigwell, 1999). Some literature describes student-centred learning in terms of the teacher instigating student activities to advance student understanding of the content to be learned (Biggs, 2003), while others describe the practice in terms of specific pedagogies that revolve around 'problems', 'projects' or 'case studies' (Boud & Feletti, 1997; Jackson & Buining, 2010; Savin-Baden & Major, 2004). Problem Based Learning (PBL), and other similar pedagogies, implies a sustained commitment to student activity, where 'problems' or 'projects' are undertaken over a designated period beyond the duration of the formal classroom encounter. This longitudinal approach is what Arthur Chickering and Zelda Gamson assert as "time plus energy equals learning" (1987, p. 5).

Entwistle describes effective teaching as "establishing a relationship between the specific subject content and the ways in which students are helped to engage with the ideas, so as to develop their own understanding" (2009, p. 3). Ramsden asserts that "good teaching and good learning are linked through the students' experiences of what we do ... we cannot teach better unless we are able to see what we are doing from their point of view" (2003, p. 84). Similarly, educators Michael Prosser and Keith Trigwell contend that:

> *"There is not one right way to teach, just as there is not one right way to learn. There are certain principles for good teaching and good learning, but the practice of learning and teaching needs to be continually invented ... There can be no good learning or teaching without a sense of excitement, without an awareness that we are all on a path of continuous discovery."* (1999, p. 175)

In the context of this study, the phrase 'effective teaching and learning' is considered a subset of 'student-centred learning' where the teacher specifically promotes a deep approach to learning that fosters independence in the student. The literature on effective teaching and learning depicts a unique partnership between the teacher, student and the content to be learned, portraying the classroom experience as active, engaging, collaborative, social and continually changing in response to student needs (Chickering, 1987; Prosser and Trigwell, 1999; Skinner, 2010.)

Therefore, this study is contextualised through the lens of effective teaching and learning as a constituent of student-centred learning. An extensive exploration of the 'effective teaching and learning' literature is presented in chapter three, including its implications for human behaviour in the classroom. The next section examines the experience of learning to reveal a gap in the literature, that the physical environment in which learning occurs has been largely ignored in the student learning literature.

2.1.5 Learning and Experience

> *"Learning is like breathing; it involves a taking in and processing of experience and a putting out or expression of what is learned."* (A. Kolb & D. Kolb, 2005, p. 208)

The experience of learning provides a critical focus in the development of constructivism through the work of educators such as John Dewey (1938), Jean Piaget (Piaget & Inhelder, 1969) and Carl Rogers (1969). Within a higher education context, David Kolb draws upon Kurt Lewin's theoretical formulation of B = f(P,E), which proposes that "behaviour is a function of the person and the environment", concluding that "personal characteristics, environmental influences and behaviour all operate in reciprocal determination, each factor influencing the others in an interlocking fashion" (D. Kolb, 1984, p. 36).

Alice Kolb and David Kolb (2005) expand on Lewin's 'field theory' (Lewin, 1943) and his concept of 'life space' to define what they call 'learning space'. The Kolb definition is not limited to the physical space in which learning occurs, but rather refers to a multitude of factors such as course structure, institutional policy and learner motivation, which influence the student's experience of learning. In their concept "learning spaces extend beyond the teacher and the classroom" (A. Kolb & D. Kolb, 2005, p. 200).

This closely aligns with Jean Lave and Etienne Wenger's 'situated learning theory', which presents a concept of learning that is explicitly 'situated' (1991). They assert that "there is no activity that is not situated ... that agent, activity, and the world mutually constitute each other" (Lave & Wenger, 1991, p. 33). In this sense they reject the notion that learning is exclusively a cognitive process, proposing a physically situated concept of learning known as 'legitimate peripheral participation'. In the classroom context Lave and Wenger recognise the student cohort as a 'community of practice' in which, through social interaction, participants develop meaning, understanding and new skills, advocating that "activities, tasks, functions, and understandings do not exist in isolation; they are part of broader systems of relations in which they have meaning" (Lave & Wenger, 1991, p. 53).

However, despite the clear recognition of learning being physically situated, Lave and Wenger avoid contextualising their concept of legitimate peripheral participation in an education institutional environment. This demonstrates Lave and Wenger's limitation in reconceptualising the classroom, where their concept of legitimate peripheral understanding could be enacted.

Kolb and Kolb also fail to recognise the physical environmental factors that influence the learner, despite their assertions relating to 'learning space' and experiential learning theory. While the author agrees with their assertions regarding the multitude of factors that can influence the student's experience of learning, they appear to disregard the magnitude of influence that arises from the experience of being physically situated in the classroom environment.

In the context of higher education, the 'experience of learning' has become a key focus in the literature, with a student's experience of learning acknowledged as a critical factor in the effectiveness of learning and influencing their approach to learning. A number of leading researchers and theorists of student-centred learning assert that learning is not an isolated experience devoid of content or material. For example, Michael Prosser and Keith Trigwell declare:

> *"The world of learning and teaching is an experienced world. From this perspective students' and teachers' experiences are always experiences of something. Students do not experience learning, they experience the learning of something. Teachers do not experience teaching, they experience the teaching of something."* (1999, p. 10)

Similarly, Paul Ramsden acknowledges that student learning is contextualised in specific areas of interest:

> *"the ways in which learners understand, or experience, or conceptualise the world around them* [including] *the concepts and methods that are characteristic of the field of learning in which they are studying."* (Ramsden, 2003, p. 6)

John Biggs defines learning as "a way of interacting with the world. As we learn, our conceptions of phenomena change, and we see the world differently." (2003, p. 13) He refers to the changing perception of the student as their understanding of a topic develops.

With Ramsden and Biggs' definitions, the experience of learning takes place in 'the world'; it takes place 'somewhere'. Student learning researchers such as Ramsden, Biggs, Prosser & Trigwell and others, recognise that learning is embedded in 'experience' yet they omit any acknowledgement of the physical location in which the learning experience occurs. They appear to separate the experience of learning from the physical situation in which learning formally occurs. This approach to the teaching and learning experience offers limited understanding of how activities and student interactions may occur other than as a cognitive enterprise. The absence of recognition relating to the impact of student learning research on the physical environment in which learning occurs forms the basis of a significant gap in the literature.

2.1.6 The Gap Between Theory and Practice

The experience of learning and where learning occurs cannot be separated in practice, as students and teachers become united in the experience of the classroom. Yet a disconnection between learning theory and learning practice is apparent. The practice of student learning is embedded in the experience of the classroom where teachers construct opportunities for student learning to occur, utilising the features, conditions and resources within the physical space, as well as drawing upon the cognitive and physical resources of the students.

One example of how learning theory ignores the physical place of learning exists in Biggs's theory of 'constructive alignment', which is presented as a framework for good teaching and learning practice (Biggs, 1996, 1999, 2003, 2005). Drawing upon the influence of constructivism, Biggs defines constructive alignment as a "system [that] aligns teaching method and assessment to the learning activities stated in the objectives, so that all aspects of this system act in accord to support appropriate learning" (2003, p. 11). Biggs proposes that the teacher's curriculum planning begins by establishing 'intended learning objectives' (ILOs); that is, what the teacher intends that students will be able to 'do' in terms of cognitive performance upon completion of the assignment or subject. Teaching and learning activities (TLAs) are subsequently devised (by teacher and students) to increase the likelihood of the ILOs being achieved, followed by assessment methods that are planned to demonstrate the extent to which the ILOs have been achieved. The three processes of ILOs, TLAs and assessment are inextricably linked, refer Figure 11.

Biggs affirms that the focus of teaching is to encourage students to actively engage in a learning process that is both contextualised and relevant to each student, deemphasising the centrality of the teacher in the learning process. However, despite Biggs's assertions about TLAs, there is no recognition of the physical environment in which the activities are intended to take place (Biggs, 1996, 2003; Biggs & Tang, 2007). While Biggs presents a generic teaching and learning schema that includes individual, collaborative and social interactions, he does not contemplate the situation in which such interactions may take place. How does he imagine collaborative interactions being activated in a lecture theatre for example?

Biggs states that "constructive alignment makes the students do the real work, the teacher simply acts as broker between the student and a learning environment that supports the appropriate learning activities" (2003, p. 27). However, Biggs does acknowledge a broader concept of 'environment' that must be interpreted as a conglomeration of the administrative and academic conditions that contribute to the student learning experience. This may include timetabling, enrolment, access to resources on and off campus and even other subjects, but does not provide any sense of awareness of how the physical classroom environment may enable or inhibit the teacher's ability to implement the teaching and learning plan, or the student's ability to engage in the planned activities.

A foundational concept of this study exists in the determination that student learning is physically situated somewhere; in classrooms, computer laboratories, in the library, at home and a myriad of other informal and tangible locations. Further, because learning is indisputably situated in a physical location, the spatial arrangement of that location needs to be purposefully designed for activities associated with teaching and learning. In other words, for learning to effectively take place, the physical environment needs to be designed with a thorough understanding of what teachers need to do to teach and what students need to do to learn.

The revelations of higher education student learning research over the last 50 years have been undermined by a gap in understanding the crucial conjuncture between theory, practice and the physical environment in which learning occurs. Although the experience of learning is recognised in the student learning literature as paramount, the experience of the physical learning environment is largely ignored in theory, or limited to case study descriptions.

Despite the lack of awareness between the theory and practice of student-centred learning and the physical environment in which learning takes place, the literature presents a compelling case for wholesale establishment of student-centred learning in higher education. This poses further questions. Can the practice of student-centred teaching and learning be effectively implemented within traditional classroom environments? How might the practice of student-centred learning influence the design of the classroom environment? The next section examines the practice of student-centre learning through the lens of various pedagogical modes such as collaborative learning, problem-based learning and peer learning and begins to explore the impact of these modes of learning on the physical classroom environment.

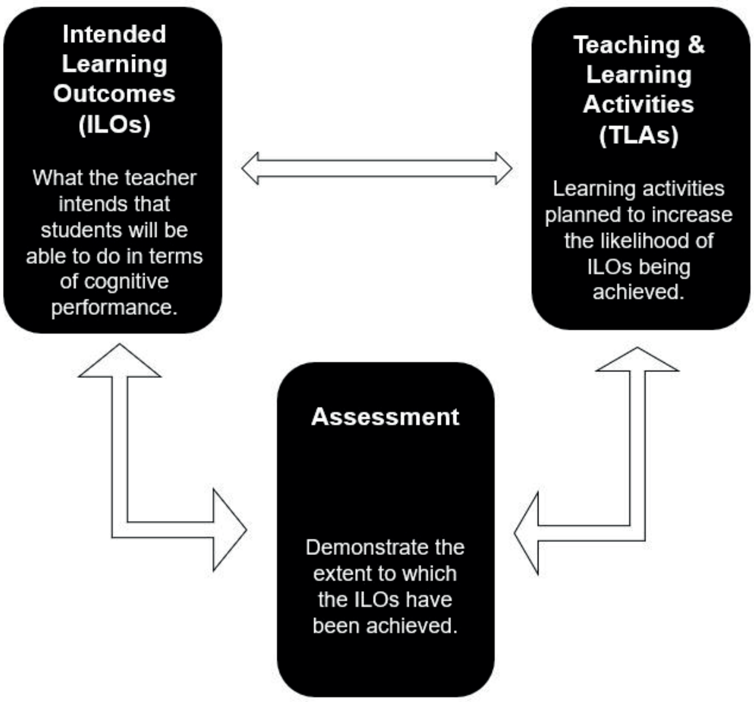


Figure 11: Constructive Alignment, adapted from John Biggs (1999).

2.1.7 Student-Centred Learning: Pedagogy to Practice

The previous sections have discussed the emergence of student-centred learning in higher education and established a gap in the literature whereby student learning *research* has largely ignored the role of the physical environment as it relates to the learning experience. This section will focus on the *practice* of student-centred learning, particularly in relation to collaborative learning, problem-based learning and peer learning. These pedagogical modes will be examined to highlight a range of teaching and learning behaviours and to consider the impact of these behaviours on the physical environment.

Attempts to define collaborative learning has revealed a contested field with little consensus (Dillenbourg, 1999; Laal & Laal, 2011). Educator Pierre Dillenbourg presents a simplistic definition of collaborative learning as a “situation in which two or more people learn or attempt to learn something together” (1999, p.1). By his own admission Dillenbourg finds this definition problematic as it does not convey the complexity of the learning processes or situations. Educators Marjan Laal and Mozhgan Laal refer to collaborative learning as an approach to teaching and learning that involves small groups of students “working together to solve a problem, complete a task or create a product” (Laal & Laal, 2011 p.491).

Academics Barkley, Major and Cross (2014) extend the definition of collaborative learning to assert three essential characteristics: 1) intentional design (students undertaken intentional learning activities created by the teacher); 2) co-labouring (all group members work equitably together toward a stated objective); and 3) meaningful learning (students demonstrate increased knowledge and understanding of the curriculum). Barkely, Major and Cross consequently present their definition of collaborative learning as “two or more students labouring together and sharing workload equitably as they progress toward intended learning outcomes” (2014, p.4).

Academic Kenneth Bruffee (1999) presents collaborative learning as a complex series of interactions between students that challenges their cultural biases and perceptions of authority. He asserts that collaborative learning “requires willingness to grant authority to peers, courage to accept the authority granted to oneself by peers, and skill in the craft of interdependence” (1999, p.12) and that students may “have to learn, sometimes against considerable resistance, to grant authority not to the teacher alone but to a peer instead of the teacher” (1999, p.14).

While each of these definitions presents a situation in which two or more students interact with each other as part of a learning process, the implication of Bruffee's description of collaborative learning in practice is particularly profound. The traditional notion of the teacher as the knowledge provider, the primary participant of what is essentially teacher-centred practice, begins to be dismantled. Notwithstanding the importance of the teacher in planning and managing the collaborative learning process (Barkley, Major & Cross, 2014; Robbins & Hoggan, 2019), collaborative learning presents the possibility that all students are contributors of knowledge, enabling their learning to flourish as a result of discussions and interactions with peers.

Consider the setting of a traditional classroom, such as a lecture theatre or tutorial room, where students sit side by side facing the same direction towards the teacher, who is located front and centre. Situating the teacher at the front and centre in this way suggests an authoritative role, whereby the teacher provides instruction, asks and answers questions and sometimes initiates other activities. As indicated by Barkley, Major and Cross, the practice of collaborative learning requires leadership and facilitation by the teacher, but in a way that encourages students to develop learning independence and initiative, which they describe as 'intentional design' (2014). Breaking down any perception of the teacher's authority in the classroom implies the need for the teacher to be able to move away from the central focus of the room. Granting authority to peers implies the need for students to be able to easily interact with each other. Lecture theatres and tutorial rooms, in their traditional layouts, make it possible for the teacher to move away from the central focus (by moving around the room), but do not necessarily make it easy for students to easily interact, with the exception of their adjacent peers. If the practice of collaborative learning requires the teacher to be able to move out of the spotlight (from the front of the classroom) and for students to easily interact with each other, it is possible to conclude that the design of traditional classrooms makes it difficult for authentic collaborative learning to effectively take place.

In the classroom, collaborative learning can take several forms, usually beginning with the formation of small groups of between two to seven participants. There is discord regarding the most effective group size, although there is some consensus regarding groups of less than eight people. Barkley, Major and Cross point out that working in pairs is highly effective, although pairs may lack diversity and that groups of six "work almost as well" (2014, p.78). Thompson et al (2015) make the case for groups of seven as the most effective size. However, Barkley, Major and Cross report on considerable research relating to group size stating:

> *"...the group be small enough so that students can participate fully and build confidence in one another yet large enough to have sufficient diversity and the necessary resources to accomplish the learning task."* (2014, p.78)

The establishment of groups, and the necessity of the participants in each group to interact with each other, requires a setting in which participants can face each other. For example, this indicates a setting in which students sitting on moveable chairs can manoeuvre themselves to be facing each other, or a table setting at which students can sit around and face each other to optimise the potential for interaction.

Problem-based learning is another distinctive mode of learning that involves collaboration in class, to promote critical thinking and problem solving. Educators Boud and Feletti define problem-based learning (PBL) as "an approach to structuring the curriculum which involves confronting students with problems from practice which provide a stimulus for learning…based upon small groups with a supportive tutor" (1997, p.1). Educators Maggi Savin-Baden and Claire Howell outline various models of problem-based learning, acknowledging that a key differential for the most successful models is the holistic design of the entire curriculum rather than a series of isolated problems (2004). Activities associated with PBL can take many varied forms, such as discussion, hypothesising, testing and ideation, potentially requiring access to digital resources or specialist eqipment (Boud, Choen & Sampson, 2001; Jackson & Buining, 2010).

What types of settings would best support activities associated with PBL? In addition to enabling the teacher to move away from the front of the classroom and providing furniture settings at which small groups can interact, what other features of the classroom may support PBL? Hypothesising, testing and ideation imply the ability for students to communicate and share ideas through the use, perhaps, of writeable surfaces, accessing technologies within the classroom or brought into the classroom by students (BYOD, Bring Your Own Device). These possibilities further imply the need for one or more students to move from the table setting to use a writeable surface or digital screen. Testing an hypothesis may warrant building a model, which may be made possible by having access to an unencumbered horizontal surface. Using BYOD technologies may mean providing access to power points and a reliable wi-fi network. Materials or equipment for testing, making and simulating may warrant storage within the classroom or space for mobile trolleys housing resources. In considering traditional classrooms again, it is difficult to imagine how front facing rows of seats and tables would support these range of activities. While tutorial rooms consist of tables and chairs that are usually moveable, they are typically arranged in high-density format, making it difficult to rearrange tables and chairs for collaboration.

Peer learning presents a variation on collaborative learning, in that it does not necessarily derive from a formal collaborative learning structure such as a timetabled class (Boud, 2001; Topping, 2017). Boud contends that “in everyday life we continually learn from each other” and that “the first approach, when stuck on a problem, is normally to ask another student, not the teacher” (p1). Although peer learning can be initiated by the teacher as a formal learning strategy, its point of differentiation from other pedagogies is that students frequently organise themselves into small groups to help each other. Topping reports that peer learning generally follows a pattern of “active participation, sharing resources and help, offering academic and personal support, encouragement and praise to each for the effort to learn, providing information and assistance, and accessing resources and materials needed” (2017, p.27). Bergmann and Sams (2012), pioneers of the ‘Flipped Learning’ concept, observed unstructured yet meaningful peer learning in their classes, stating:

> *“As we roam around the class, we notice the students developing their own collaborative groups. Students are helping each other learn instead of relying on the teacher as the sole disseminator of knowledge. It is truly magical to observe. We are often in awe of how well our students work together and learn from each other”* (Bergmann & Sams, 2012, p.27).

While peer learning can occur within informal learning environments as well as classrooms, the implication for the design of the classroom is similar to considerations for collaborative learning and PBL. The types of interactions between peers implies the need for settings at which students can interact and work together, with access to resources to support their learning needs.

Descriptions of student-centred learning practice throughout the literature present tangible clues to inform the development of physical learning environments, designed with the intention of supporting collaboration, interaction and knowledge sharing. Psychologist James Gibson coined the term ‘affordance’ to describe how the environment enables transactions between people and their environments (1950). Within this context, the design of the classroom to include tables and chairs arranged for small groups, afford students the ability to collaborate and interact.

This section has discussed the practice of student-centred pedagogies such as collaborative learning, PBL and peer learning and questioned the efficacy of implementing these pedagogies in traditional classrooms where students typically sit side by side facing the teacher located at the front of the classroom. The design of traditional classrooms presents difficulties for the implementation of activities and behaviours associated with the practice of student-centred learning. Through the examination of collaborative learning, PBL and peer learning, a range of spatial characteristics that more effectively support student-centred learning have emerged. These characteristics include providing space for the teacher to move away from the front of the classroom (and effectively de-emphasising the importance of the 'front' of the classroom), providing furniture settings at which students can effectively collaborate, for example tables and chairs suitable for small groups, and providing access to educational resources in the room, such as writeable surfaces, digital screens and good quality wi-fi networks. The next section explores behaviour and environment through a critical review of the literature surrounding the field of environmental psychology and in particular in relation to spaces for learning.

2.2 PART 2: ENVIRONMENTAL PSYCHOLOGY AND LEARNING ENVIRONMENTS

This section will demonstrate how the environmental psychology discourse presents a compelling account of the relationship between the physically constructed environment and human behaviour, asserting a causal relationship between the two elements. According to the accumulated findings of numerous research studies, human behaviour is influenced by elements within the constructed environment (Hall, 1970; Lawson, 2001; Proshansky, Ittelson & Rivlin, 1970; Tuan, 1977; Gifford, 2002; Thiel, 1997). Critically for this study, these findings establish the possibility that the physical environment can be explicitly manipulated by design to increase the likelihood of certain behaviours being enacted within a particular setting.

The field of environmental psychology emerged as a unique topic within the domain of social sciences during the 1960s and 1970s. Despite its potential to profoundly influence architecture and the design of buildings, architects have largely ignored environmental psychology research. Educational planner, Kenn Fisher (2004) contends that architects have largely rejected environmental psychology research in deference to propositions, aesthetics and speculation, amid concerns that research findings present a deterministic view of the world that will ultimately suffocate the creative process. However, the position of this study is that understanding human behaviour – in particular student learning behaviour – presents the opportunity to design learning environments that align with known desirable learning behaviours, without necessarily resorting to template solutions.

It is extraordinary that more attention has not been assigned to the behavioural effect of school and university environments on the expectations, intentions and actions of teachers and students. Literature pertaining to learning behaviour in the field of environmental psychology is glaringly deficient in relation to school environments, and even more so with regard to university settings. This is in stark contrast to environmental psychology studies in similarly important societal institutions such as hospitals (Ampt, Harris & Maxwell, 2008; Ulrich & Zimring, 2004), psychiatric wards (Proshansky, Ittelson & Rivlin, 1970) and prisons (Anson & Hancock, 1992; Paulus, 1988), with the aim of designing environments to influence behaviour appropriate to those institutions. Significant studies have also been undertaken in community housing to investigate design as a means of reducing crime and delinquency and improving safety and inclusion of residents (Gifford, 2002; Lawson, 2001). Further, considerable research has been undertaken in workplaces observing the behaviour of workers, with the aim of designing workplaces to increase productivity (Becker &

Steele, 1995; Clements-Croome, 2006; Kaarlela-Tuomaala, Helenius, Keskinen & Hongisto, 2009).

The lack of emphasis on studying educational environments is surprising when one considers the importance placed politically, culturally, financially and emotionally on formal education. Almost everybody attends school for a considerable duration of their formative years, yet there has been little engagement in the discourse on the physical environment in the context of teaching and learning behaviour. Where environmental psychology studies relating to schools have been undertaken they have primarily focused on the environmental indoor quality; that is, how lighting, thermal comfort, air quality and building condition affect the learning process (Clark, 2002; Gifford, 2002; Marchand, Nardi, Reynolds & Pamoukov, 2014; Nair & Fielding, 2005). These are important matters in themselves (though not the focus of this study) but the fact remains that there is scant reference to classroom environments and how they enable or inhibit teaching and learning behaviour. Just as the student learning discourse has shown little awareness of the physical environment, similarly the environmental psychology field has shown little interest in the teaching and learning process and the spaces in which teaching and learning takes place. There are, however, a small number of relevant examples that are expanded upon in this chapter.

2.2.1 Educational Settings and Student Behaviour

The environmental psychology discourse is poised around the pedagogical limitations of traditional learning environments, rather than elaborating on spatial characteristics that support desirable teaching and learning behaviours. For example, psychologist Elizabeth Richardson questions the value of churning out standardised classrooms, recognising that while "most teachers are trying to encourage the articulate exchange of knowledge and ideas, [the school classroom] clings to a physical arrangement that inhibits it" (1970, p. 388). Richardson presents the possibility that classrooms may be rearranged to better suit discussion and enquiry-based learning, but offers little sense of what this transformation would look like, nor any insight into the key components of an improved setting such as student furniture.

A considerable number of studies have been undertaken in relation to the lecture theatre setting, analysing where students sit relational to academic performance (Becker, Sommer, Bee & Oxley, 1973; Pichierri & Guido, 2016; Shernoff et al., 2017; Waktola, 2015; Wong, Sommer & Cook, 1992). The concluding consensus is that students who sit closer to the front of a lecture theatre are likely to be more engaged and achieve better results. Students who sit closer to the back of the lecture theatre are likely to be more distracted and achieve lower grades, which Waktola describes as the "distance decay effect" (2015, p82).

While these studies provide compelling insights into the diminishing performance of students the closer they are regularly located to the rear of a lecture theatre, they do not establish any sense of the lecturer trying to instigate a teaching and learning process other than the act of lecturing. The instructor of the accounting course, as reported in Shernoff et al. (2017), "formed the impression that large lecture classrooms are not ideal learning environments for a demanding subject such as financial accounting, and that the back of the classroom can be a particularly unconducive environment for learning" (p.63).

There are two unique studies contextualised within a non-lecture university learning setting. One is presented by educators Peter Horowitz and David Otto (1973), who investigated student learning outcomes relating to two classroom typologies. The second study, by psychologist Robert Sommer and design lecturer Helge Olsen (1980), reported on student engagement relating to learning conducted in two classroom typologies.

Horowitz and Otto compared the academic results of two groups of university students: one group situated in a 'traditional' classroom and the other group situated in a purpose-built 'alternative' classroom. The alternative classroom was furnished with vibrant colour, flexible seating boxes that could convert to tables, movable wall panels that could subdivide the space or remain open and a complex lighting system designed to enable changes in ambience. Prior to the study, Horowitz and Otto had anticipated the range of pedagogical possibilities:

> *"A class could begin with all students in a single campfire type circle in the center of the room. When the need for buzz-groups arose, smaller groups could move to the corners, and the panels could function as screens. Or the class may sit on one side of the room and view presentations by students on the other side, where half-hexagonal boxes could serve as a work area and the panels as backdrops."* (1973, pp. 2–3)

In an attempt to reduce as many other variables as possible, 'the lectures and discussions in both classes were identical. The syllabus reading lists, assignments, term paper topics and final examination were identical' (Horowitz & Otto, 1973, p. 5). The assessment results for both groups of students were compared with the expectation that students in the alternative classroom would achieve higher grades. However, the findings did not support this hypothesis, although the authors conclude that 'the alternative teaching facility is as conducive to learning as a traditional classroom' (Horowitz & Otto, 1973, p. 10).

Perhaps more importantly, Horowitz and Otto noticed critical differences in student behaviour between the two cohorts. Students in the alternative classroom had a better attendance record, exhibited greater participation behaviour and cohesion as a group, and consulted with the teacher more regularly between classes, compared with students in the traditional classroom (Horowitz & Otto, 1973). These student behaviours demonstrate high levels of engagement with the content being learned, as well as a sense of knowledge being constructed in a social setting—factors that are recognised in educational literature as exemplifying effective teaching and learning (Prosser & Trigwell, 1999; Garrison & Archer, 2000; Laurillard, 2002). Therefore, it is somewhat surprising that student results in the alternative classroom were not notably higher than students who studied in the traditional classroom.

Sommer Olsen's study was similar in many ways to Horowitz & Otto. In his earlier research, Sommer (1967) arrives at the proposition that very little classroom participation actually occurs in lectures and tutorials, stating "the straight row arrangement conveyed the message that only the teacher was capable of responding to a student's query" (Sommer & Olsen, 1980, p. 4). In response, Sommer and Olsen initiated an experimental classroom for tutorials, an alternative to the typical rows of desks all facing the teacher, a classroom that was branded the 'soft classroom'. The soft classroom, built in 1974, consisted of upholstered bench seats around the perimeter of the room, with carpet on the floor (unusual at the time) and adjustable lighting. The room also featured decorative mobiles and timber panels "to overcome the rectilinear room shape" (Sommer & Olsen, 1980, p. 10). Two parallel classes participated in the study, both implementing the same curriculum, one undertaken in the soft classroom, the other in a conventional tutorial room with rows of desks facing the teacher. The critical conclusion from the study was that student participation significantly increased in the soft classroom compared with the conventional tutorial room.

A second evaluation of the soft classroom, conducted some 17 years after its construction and adopting the same methodologies as the original study, led to the conclusion that 'the soft classroom continues to realise its original goal of increased student participation' (Wong, Sommer & Cook, 1992, p.343). However, it is important to acknowledge that the nature of participation as reported in both evaluations of the soft classroom were limited to teacher-led discussion. Some teachers were reported to have identified that the soft classroom was unsuitable for certain teaching methods, particularly pertaining to mathematics where large wall surfaces were typically required for expanding equations. To this, Wong et al. respond that notwithstanding "the occasional mismatch between users and layout, an innovative classroom may still yield more public good" (1992, p. 342).

Critically, Sommer & Olsen's study raises more questions, which unfortunately remain unanswered. For example, there was no attempt to change teaching behaviour within the alternative classroom; both situations involved a teacher-led discussion. While it is encouraging that student participation increased in the alternative classroom, it would have been useful to have investigated student behaviour during student-centred activities.

In contrast, Horowitz & Otto reported on their expectations of teacher and student behaviour within their study, indicating a combination of teacher-led and student-centred activities. Despite their conclusions that student performance in the 'soft classroom' did not improve compared to the traditional tutorial room, Horowitz & Otto observed student behaviours that indicated improved levels of engagement in the 'soft classroom' compared to the tutorial room. The inclusion of the pedagogical intentions in Horowitz & Otto's study reinforces the importance of including an account of the teacher's approach to teaching, which has been influential in developing the methodology for the present study, to be detailed in Chapter 4.

Educator, Carol Weinstein (1979) reports on literature surrounding physical education environments, much of which is contextualised in schools. She articulates an overwhelming sense of the conflicted state of research in the field, acknowledging that environmental variables are too disparate to yield reliable consensus on findings. Attempts to draw conclusions on academic achievement are fraught with inconsistencies for the same reason. The variables that stand to affect learning behaviours are many. For example, the teacher's approach to teaching, the student's motivation to learn and the interpersonal relationships among the student cohort will all have an effect on student behaviour. There are also the physical spatial qualities, such as access to natural light, thermal comfort and air quality that can significantly affect a student's capacity to concentrate. Finally, a student's physiological and psychological wellbeing will also influence their learning behaviour. It is virtually impossible to devise an experiment where the variables in a learning encounter can remain stable enough to draw clear conclusions regarding the relationship between specific environmental conditions and student learning outcomes.

It is necessary, therefore, to identify other desirable behaviours that may indicate positive learning experiences and outcomes. For example, Horowitz and Otto's (1973) study of an 'alternative classroom' reports improved student attendance to class, increased participation in class discussion and increased consultation and engagement with the teacher between classes, findings that arguably indicate positive learning behaviours. Similarly, Sommer and Olsen (1980) in their study of the 'soft classroom' report student participation in class was two to three times higher than in the traditional classroom—findings that are supported in Wong's subsequent duplicate study (Wong et al., 1992).

The studies of education environments reported by Weinstein (1979) and Wong et al. (1992) do reveal consensus on one issue: all researchers appear to agree that student behaviour is affected by the physical environment. This establishes the possibility that if desirable learning behaviours can be identified, then education spaces can be designed deliberately to increase the likelihood of those desirable learning behaviours being enacted.

In this context, Weinstein's literature review provides a crucial reference point for the present study as it eloquently articulates the quagmire of issues relating to the study of the physical environment and student behaviour (Weinstein, 1979, 1981). The difficulties identified by Weinstein are particularly relevant in terms of influencing the type of data to be collected, the process of analysis and the conclusions that can realistically be made. The complexity of issues surrounding the study of people in the built environment has led to the objective in this study of simplifying the types of data being collected and providing a narrow focus for the data analysis. Consequently the methodology in this study, to be reported on in chapter four, focuses on: a) identifying the teacher's pedagogical intention for the class to be observed; b) anticipating the activities and student behaviours that would occur during the class; and importantly c) the teacher's understanding of what was possible for students to be doing in the classroom. The teacher's perspective was then related to observations of the teaching and learning encounter to establish if the teacher's intentions had been realised. This became the process for each classroom observation undertaken throughout this study.

Another major factor that has been shown to affect learning and behaviour, and thus the design of classrooms, relates to how many students physically occupy the learning space at any one time. This is referred to by Gifford (2002) as 'spatial density' and is considered a tangible factor that influences learning outcomes. Psychologist, Robert Gifford, reports on a study of class size related to achievement, which emphatically shows that achievement increases as class size decreases (Gifford, 2002). However, the context for this study was again schools, not university learning environments. Further, there was little interrogation of other spatial elements that may have also influenced student performance. Spatial density is, however, a critical issue for teaching and learning in higher education. Lecture theatres are deliberately designed to maximise density of students, without any apparent concern for the behavioural or learning implications for students. The high spatial density of lecture theatres, reinforced by rows of fixed seating, limits the range of possible student behaviours to sitting, listening, note-taking or talking to an adjacent person. NGLEs, as will be detailed in the next section, are characterised by more spacious settings with considerably lower spatial densities than lecture theatres.

The limited number of studies that have explored the relationship between spatial design and learning behaviour were largely undertaken during the 1970s and early 1980s, reflecting interest in the burgeoning field of environmental psychology during that time. In the last 40 years very few environmental psychology studies with an educational context have been published, despite the findings of early studies identifying great potential for such research. It is unclear whether contradictory findings have contributed to the lethargy of environmental psychology studies in education spaces. If anything, the contradictions in the literature increase the imperative to repeat findings to seek clarity and continue exploring student learning behaviour. Gifford demonstrates renewed interest in the field through his 2002 text Environmental Psychology: Principles and Practice; however, the renaissance of the discourse has largely been led by architects and designers such as Lennie Scott-Webber (2004), Prakash Nair and Randall Fielding (2005), Henry Sanoff (2006a) and Peter Lippman (2010), rather than the social scientists who pioneered the discourse.

2.2.2 A Renaissance of Environmental Psychology

Nair and Fielding's *The Language of School Design* (2005) presents design ideas for school settings with the explicit objective of student learning behaviours. They challenge the 'cells and bells' paradigm by proposing a range of design interventions that support eighteen learning modalities (Nair & Fielding, 2005, p. 19) including independent learning, collaborative learning, online learning and other active learning processes. While the text proposes several design responses to educational imperatives, it disappointingly lacks rigour in its presentation by omitting the pedagogical detail.

Architect, Henry Sanoff, chronicles his process of designing 'responsive schools', demonstrating an understanding of educational theory, objectives and teaching practice (Sanoff, 2006b). He also recounts his participatory design process whereby students, teachers and community stakeholders contribute through drawings, poetry and other creative means. Sanoff's work presents a useful framework for an effective design process, but is contextualised in school environments and does little to advance the discourse in higher education.

Similarly, Lippman's *Evidence-Based Design* (2010) draws strongly from his architectural experience designing schools. However, Lippman's design process is followed through with ethnographic evaluations of students in their classroom environment. Critically for the context of this study, not only does Lippman make observations of teacher and student behaviours, he links their behaviour to educational theories such as constructivism, genetic determinism, practice theory and multiple intelligences. Lippman recognises that "students' transactions influence and shape their physical environment and, in turn, the physical environment shapes students" (2010, p. 137). While Lippman's work is predominantly embedded within the design of schools, there are examples of university applications, demonstrating the potential transfer of his design framework into a higher education context.

In 2004, interior designer, Lennie Scott-Webber, published a seminal work titled *In Sync: Environmental Behaviour Research and the Design of Learning Spaces*, which provides a pivotal reference for this study. It represents one of the few examples of environmental psychology literature that presents a higher education context for learning spaces. Scott-Webber draws upon considerable environmental psychology resources to distinguish between environments for 'delivering knowledge', 'applying knowledge', 'creating knowledge', 'communicating knowledge' and 'using knowledge for decision making'. This schema acknowledges teaching and learning behaviours, recognising that some settings are more appropriate for teaching ('delivering knowledge') while others are better suited to learning ('applying', 'creating' and 'communicating' knowledge). Scott-Webber concludes:

> *"generating spaces that support intended behaviours provides architects, interior designers, and planners with a set of tools and a language that can result in innovative spatial solutions offering communities of learners settings that are sensitive to behavioural needs."* (2004, p. 95)

However, while Scott-Webber presents a behavioural and spatial framework for learning environments, there is a lack of explanation as to how learning environments may improve the quality of teaching and learning (2004). The design intentions would have benefitted from references to educational theory and practice, as evidence of their educational appropriateness and to support the behavioural assertions.

This appears to be a common issue in multidisciplinary fields, where researchers with expertise in one area (e.g., design) demonstrate limitations in others (e.g., education).

Despite the environmental psychology discourse presenting compelling evidence regarding the relationship between human behaviour and the physical environment, there are conspicuous gaps in the literature. For example, the texts by Nair & Fielding (2005) and Scott-Webber (2004) omitted documentation of pedagogical practice, which would have added significant value to their work. While it is important to acknowledge that human behaviour is influenced by the physical environment, there is an even greater need to understand the specific nature of desirable learning behaviours to manipulate the physical setting and optimise its effects.

Robert Gifford presents a position on the design of learning environments that does potentially bridge this gap, establishing a fundamental conjuncture between the literature surrounding student learning research and environmental psychology. Gifford asserts that:

> *"There is no single best learning setting. The best physical settings are those congruent with the type of material being learned, the goals of the class and the characteristics of the learners."* (2002, p. 299)

Gifford's view forms a strong parallel with Biggs's theory of 'constructive alignment' (Biggs, 1996, 1999; Biggs & Tang, 2007), through his reference to the 'congruence' between the 'goals of the class' and 'material being learned'. As described in Section 1 of this chapter, constructive alignment refers to the process of the teacher planning TLAs designed to enable students to achieve ILOs and validated through assessment tasks devised to demonstrate achievement of these learning objectives. The terms 'congruent' and 'alignment' have similar meaning in this context, providing a concept of cooperation or agreement between the fields of environmental psychology and student learning research. This critical discovery forms a vital missing link between the two discourses. Gifford reminds the reader that the physical environment does influence student learning, where the most effective settings are those that are aligned with the educational approach of the teacher, students and the content to be learned.

This section has argued in the positive that the physical environment does impact the human behaviours that occur within. In the context of education spaces this establishes the position that the design of learning environments would influence the type of teaching and learning behaviours that could be enabled. Until the end of the 20th century, the fields of environmental psychology and student learning research rarely intersected, despite the potential benefits of doing so. However, the fields did begin to intersect in the late 1990s. This change was not brought about architects, psychologists or education theorists, but rather, was led by a small number of higher education teachers. These teachers, as the next section will outline, realised their preferred student-centred learning practices were very difficult to implement within the traditional classrooms provided on campus. The next section explores how a new type of classroom typology emerged in higher education as a result of the insights of key educators who realised their practice of student-centred learning required the development of a new and purposeful space typology on campus.

2.3 PART 3: THE HIGHER EDUCATION LEARNING SPACE DESIGN DISCOURSE

Key participants in the environmental psychology discourse were generally psychologists, geographers, architects and designers. The limited focus on education spaces, especially higher education learning environments, was most likely caused by the apparent lack of engagement in the field by educators. Exponents of environmental psychology did make interesting observations of learning spaces but their insights do not appear to have been realised by educators. The potential to adapt higher education classrooms into more engaging spaces existed in the 1970s and 1980s, but the gap between the two discourses prevented any alliance between the fields of research. However, towards the end of the 20th century a number of educators began to question the validity of traditional classrooms as appropriate environments in which to implement student-centred learning.

One of the earliest representations of a global change in attitudes towards university campus planning and the design of learning spaces emerged from a conference titled '*Towards 2000: Facilities for Tertiary Education*' organised by the Organisation for Economic Co-operation and Development (OECD) Programme on Educational Building (PEB), held in Crete in 1995 (Corbett, 1998). Participants from 20 OECD member countries, representing a broad range of stakeholders in higher education building and procurement, discussed new and developing issues in designing facilities for tertiary education. Attention was primarily focused on how to design campuses and facilities in a climate of significant institutional change, ranging from a dramatic increase in student numbers, decreasing public funding, evolving cultural and academic expectations and the effect of the technology revolution. However, an awareness of the shifting educational paradigm and its effects on the planning process is apparent in the report. Lindsay Ames, then Head of Capital Works and Research at TAFE NSW, contributed an emerging perspective:

> *"Considerable demands are placed on educationalists to come to terms with current technologies in curriculum delivery, and then to express facility requirements to the planners. Planners will need to understand technologies and develop a schedule of accommodation which takes account of the paradigm shift in education and learning ... the student of tomorrow will dictate the facilities that will be required and will outstrip any new or innovative system we can imagine."* (Ames, in Corbett, 1998, pp. 78–79)

The Corbett report not only demonstrates a multidisciplinary awareness of the changing climate in higher education with contributions from academics, facility planners and architects, but also conveys the sense of a pending metamorphosis of the university campus.

The OECD conference in Europe was paralleled in the US by a small number of examples of 'innovative' classrooms that emerged in the late 20th century, prompting discerning academics to engage in a new discourse regarding the practice of teaching and learning in new types of learning spaces. Discussions, conference themes and theoretical speculations provided momentum for a variety of stakeholders to weigh into the debate, leading to a new field of design, research and pedagogical practice. This new discourse is referred to in this study as the 'learning space design discourse'. In this discourse participants recognised the difficulty of implementing student-centred learning in traditional classrooms designed for teacher-centred practice, and that student-centred learning demanded a different classroom typology—a purposefully designed new generation learning environment.

2.3.1 Connecting Pedagogy and Place

The theory and practice of student-centred learning presents an unambiguous representation of teaching and learning as being active, interactive and collaborative (Entwistle, 2009; Prosser & Trigwell, 1999; Ramsden, 2003). Yet, as the discussion here has established, the theory fails to acknowledge the effect of the physical environment in which teaching and learning is situated. In a highly cited paper that in many ways heralds the beginning of the 'learning space discourse', Jamieson, Fisher, Gilding, Taylor and Trevitt acknowledge the disconnect between educational theory and its situated practice, contending:

> *"The issue of the on-campus built environment has not been a primary concern in the literature dealing with the teaching and learning process in higher education. The absence of concern with the place of teaching and learning is evident in the influential student learning literature that has emerged since the 1970s."* (2000, p. 225)

As Jamieson and colleagues recognise from the teaching and learning literature, learning must take place 'somewhere' and that 'somewhere' may include of a variety of places that exist anywhere between the university classroom and the student's home. They explicitly criticise educational settings that "reinforce teacher-centred pedagogical practices", contending that the misalignment between pedagogy and space has been caused by a disparate procurement process whereby "designers are separated from the ultimate building inhabitants by a builder, a project manager and a facility manager" (Jamieson et al., 2000, p. 227).

Towards the end of the 20th century a small number of 'innovative' learning environments rose to prominence and included the Math Emporium at Virginia Tech, the Prototype Laptop Classroom at Ohio Dominican College and The Studio at the University of Dayton (Dittoe, 2002). Each of these learning spaces was initiated for a different reason. The Math Emporium was developed in the early 1990s to meet the demands of increasing student enrolments and a desire of the university to implement significant investment in technology. The Laptop Classroom was developed in 1994 to facilitate a new student-centred laptop program, recognising that teacher-centred traditional classrooms would not meet their teaching and learning requirements. The Studio was initiated as an 'experimental' classroom to "allow faculty and students to explore and develop better teaching and learning strategies" (Dittoe, 2002, p. 86). These spaces were unique because they were designed explicitly in response to articulated teaching and learning issues and with the intention of improving teaching and learning. The publicity surrounding these early examples provoked discussions and interest that have contributed to early conceptions of new learning space typologies.

Educators Nancy Van Note Chism and Deborah Bickford provide a pertinent account of the pedagogical considerations surrounding learning spaces, motivated by "the lack of extensive dialogue on the importance of learning spaces in higher education" (2002, p. 1). In particular, Van Note Chism recognises the spatial consequences of a paradigm shift from teacher-centred to student-centred learning, with the observation:

> *"In this new constructivist thinking, where teachers serve as facilitators for active engagement ... learning space needs are seen to be far more dynamic and situational than they were under the transmission model."* (2002, p. 10)

In traditional classrooms, sometimes what is not possible in terms of teaching and learning is more evident than what is possible, as information technology academics Thomas Skill and Brian Young point out:

> *"The critical connection between physical spaces and active learning cannot be overstated. Teachers, curriculum designers, and learners scale their aspirations for learning experiences based on the constraints imposed by the learning environment. If the learning situation lacks sufficient space for group-driven activities, that option is not considered."* (2002, p. 27)

In Skill and Young's apropos observation we are reminded that what teachers and students perceive as being possible in the physical environment will vary. These varying perceptions contribute to Fisher's concept of 'spatial literacy', which describes a person's awareness of the behavioural possibilities inherent in the design of a physical space (Fisher, 2004). Some people will take the physical conditions for granted, not realising the teaching and learning opportunities the space presents, while others will consciously or subconsciously 'read' the physical environment and inherently understand the range of activities afforded by the space. This concept is critical for teachers while they are planning learning activities for their class. By understanding the physical dimensions of the room, the limitations and affordances of the furniture (Can tables and chairs move? How many people can group together easily?) and the resources available within the room, teachers can construct meaningful learning experiences. It requires a conscious effort to connect teaching and learning practice with the physical environment. If a teacher does not naturally possess this insight it needs to be 'switched on' (for example, through professional development) to become effective.

Another body of work that informs the present study was generated by educational planner, Susan Wolff (2002), an academic who worked with both educators and architects as part of her PhD study on the design of learning environments for project-based learning. Her intense engagement across both disciplines established a competency of language between disciplines that enabled the translation from pedagogical narrative to spatial consequences. As a result of a series of design workshops conducted with educators and architects, Wolff established a series of design features (see Figure 12) that can be applied to any context where student-centred learning is anticipated. Wolff's matrix presents a crucial reference point to this study as an example of uniting the discourses of pedagogy and design, while refraining from prescribing the detailed design of a learning environment. Wolff's study provides a creative pathway for the architect while expressing an understanding of the activities to be enabled through the implementation of project based learning.

The work of Corbett (1998), Jamieson et al. (2000), Van Note Chism and Bickford (2002), Wolff (2002) and others represents a pivotal intervention into the discourse on pedagogy and space at a time when universities were beginning to experiment with new types of learning environments. These critical studies, undertaken by educators (not architects or designers), pioneered the 'learning space design discourse' that fundamentally and explicitly connects educational theory and practice with the design of spaces for learning.

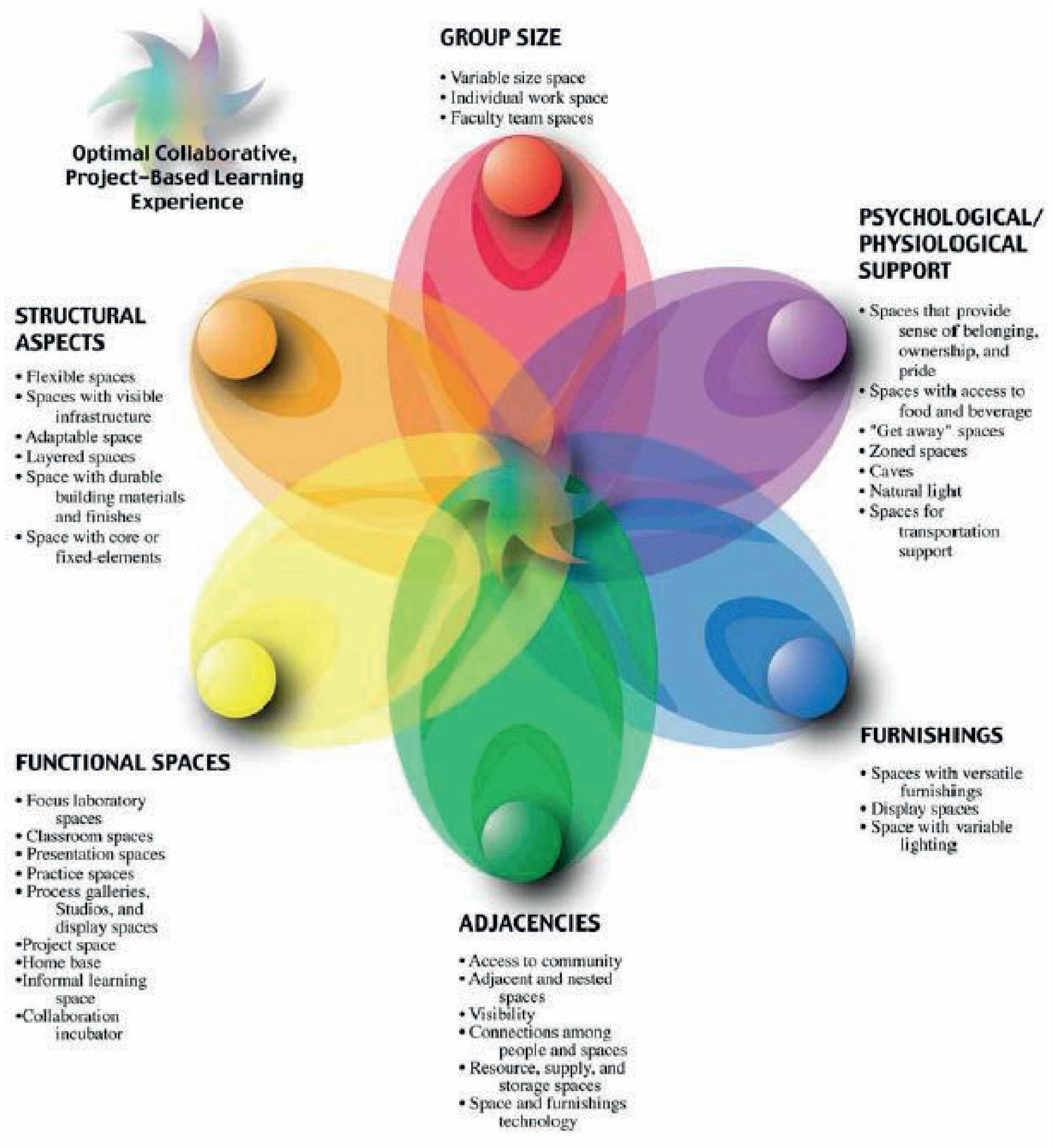


Figure 12: Design Features of the Physical Environment for Collaborative, Project-Based Learning.
Source: Susan Wolff (2002).

In what presages the vibrant learning space design discourse that has evolved in the last 15 years, Van Note Chism and Bickford conclude their influential text by urging universities to:

> *"abandon their business-as-usual assumptions in constructing and renovating learning spaces ... The present era demands radical rethinking rather than tinkering ... while the challenge is enormous, the work is creative and exciting, and most of all, fundamental to the quality of learning in the future. Higher education has no other option than to embrace it, should it intend to flourish in the coming years."* (2002, p. 97)

University leaders were sufficiently influenced by these educational pioneers to invest in new types of learning environments, designed deliberately and purposefully to align with specific student-centred approaches to learning.

2.3.2 Early Examples of New Generation Learning Environments

As expressed in chapter one, this study defines a NGLE as 'a single space or suite of settings designed to improve teaching and learning through the provision of physical environments that will enable more student-centred teaching and learning processes'. These new types of learning spaces emerged out of demand expressed by educators seeking to implement student-centred learning. Initially, a small number of educators recognised the spatial limitations of traditional classrooms in facilitating a student-centred approach to learning, leading to discussions about the optimal classroom arrangement that would enable student-centred learning activities to take place.

The following two examples of early NGLEs—one at the Australian National University (ANU) in Australia and the other at Massachusetts Institute of Technology (MIT) in the US—demonstrate the leading role of educators in initiating the new classroom environment. Facility managers play a vital role in the procurement process because of their direct relationship with both academics and architects, as well as their ability to allocate space to the new learning space initiative.

2.3.3 The Centre of Educational Development and Academic Methods Learning Studio, ANU

Educator, Chris Trevitt, reports on an experimental classroom initiated by the Centre of Educational Development and Academic Methods (CEDAM) at the ANU (Jamieson et al., 2000; Trevitt, 1999). The premise of the new space was initially to explore a reduced ratio of computers to students, with the secondary intention of responding to educational literature that fosters learning through collaboration.

Its reference as “novel physical infrastructure” (Trevitt, 1999, p. 2) highlights the studio’s unparalleled place on campus. The CEDAM Learning Studio has a capacity of 25 students with five computers available around the perimeter of the room. Rectangular tables and chairs with castor wheels can be easily reconfigured to accommodate a variety of settings. An adjacent kitchenette is considered an extension of the learning space. Teachers interested in developing their teaching practice were invited to test the space and requested to document their reflections throughout the semester. Students were also requested to complete surveys pertaining to their experiences of learning in the Learning Studio. Responses varied widely but there were sufficient positive reflections to indicate this type of environment was worth pursuing. Some academics reported they changed their teaching practice to make appropriate use of the room’s features, confirming the contention that behaviour, in this case teaching behaviour, can be influenced by the physical environment. Trevitt further reflects:

> *“As insights into successful initiatives build up in this fashion, an increasing range of experiences becomes available for use in different internal fora (e.g., workshops, staff consultations, etc.) which then helps stimulate the next generation of ideas and developments.”* (1999, p. 14)

Trevitt’s preliminary study committed to a continuing process of learning from the Learning Studio experience, as a place for academics to explore and improve their teaching practice. Importantly, Trevitt’s foray into the ‘design of learning spaces’ and contribution to the learning space design discourse may have influenced academics to exert pressure for similar initiatives in other Australian universities.

2.3.4 Technology-Enabled Active Learning Studio, MIT

The Technology-Enabled Active Learning (TEAL) Laboratory at MIT was created in response to a rejuvenated first year physics curriculum developed to address declining lecture attendance and increasing failure rates (Belcher, 2001; Dori & Belcher, 2005). The physics professors responsible for reconceptualising the curriculum recognised that the interactive, technology-enhanced program they planned could not be implemented in a lecture theatre, setting in motion the fit-out of a new type of purpose-built learning environment, the TEAL Studio. It is a flat floor space with a capacity of 117 students distributed across 13

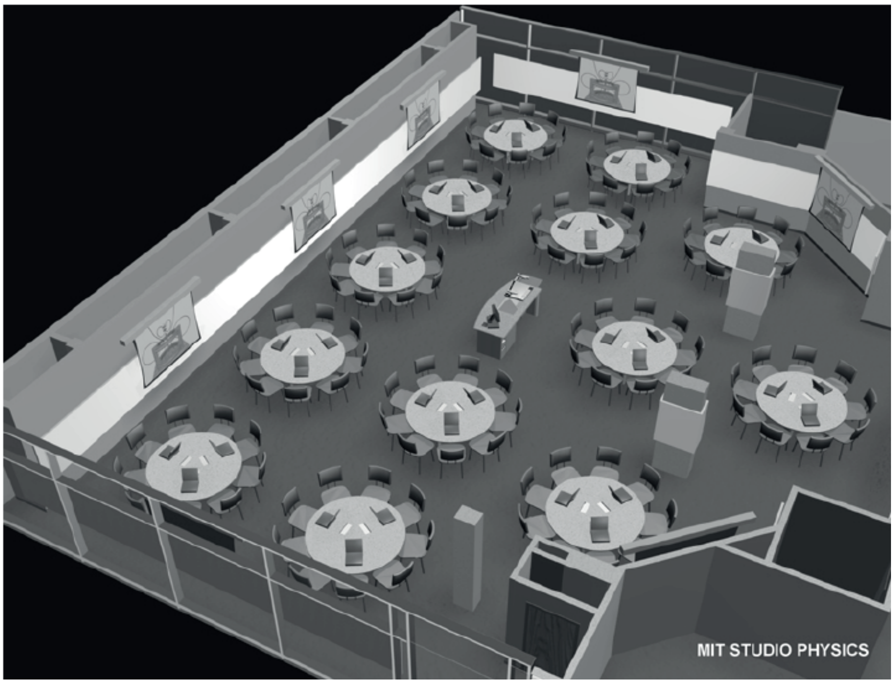


Figure 13: 3D Representation of the TEAL Classroom at MIT (Dori & Belcher, 2005)


Figure 14: The TEAL Classroom at MIT.
Source: Author

round tables, each catering for three groups of three students (see Figures 13 & 14). Multiple projection screens around the walls remove any sense of a classroom 'front' associated with teacher-centred practice. Classes consist of short lectures presented on multiple screens, interspersed with small group activities and discussion.

Critically, the class is not supported by a single professor, as would be the convention in a single lecture encounter; rather the TEAL Studio is led by a professor and supported by a team of junior academics who are employed to roam the room to answer questions and engage with student groups as they undertake prescribed learning activities.

The TEAL Studio design was underpinned by the theory of social constructivism and a belief that "active learning environments encourage students to engage in solving problems, sharing ideas, giving feedback, and teaching each other" (Dori & Belcher, 2005, p. 247). Student outcomes were closely monitored for two cohorts of students undertaking a first year physics course, with one cohort learning in the TEAL Studio and the other undertaking the same course in traditional lecture/tutorial mode. Findings indicated that not only did failure rates of students dramatically decline in the TEAL Studio, but that "students who studied in the TEAL format significantly improved their conceptual understanding of the various complex phenomena associated with [the course]" (Dori & Belcher, 2005, p.267). Yehudit Judy Dori and John Belcher further contend:

> *"These findings indicate that an appropriate learning environment that fosters social constructivism is instrumental in improving the achievements of students at all academic levels. The technology-rich engagement atmosphere and the group interactions enabled the high achievers to blossom while teaching their peers. This setting also facilitated upward mobility of the intermediate and low achievers, thereby reducing failure rate and obtaining overall better results."*
>
> (Dori & Belcher, 2005, p. 270)

While Dori and Belcher proclaim that learning in the TEAL Studio led to better student outcomes, it is impossible to distinguish between the positive effect of the pedagogical shift (to problem based learning), the addition of multiple academic staff to support students in-class and the positive effect of the design of the environment. The variables (including the physiological and psychological wellbeing of students, which were not considered in Dori & Belcher's study) are too wide ranging to isolate from the physical experience of the environment (Lackney, 2001; Weinstein, 1979; Zimring & Reizenstein, 1980). A student's learning outcome is inextricably linked to the approach of the teacher and assessment methods, which will also influence the student's motivation and approach to learning (Biggs & Tang, 2007; Prosser & Trigwell, 1999; Ramsden, 2003). While the physical environment may facilitate activities that promote student-centred learning, the degree to which this occurs will be contingent upon the confluence of a variety of factors, including the student's wellbeing, the teacher's practice and the student's conception of learning, motivation and approach to learning.

The TEAL case study is a positive educational example of a physics course where professors were sufficiently compelled to transform the teacher-centred model of teaching physics to a student-centred experience of learning. The professors planned how they wanted students to experience learning physics and then, recognising the critical conjuncture with the physical environment, created a classroom that would enable the learning process to be activated. The apparent improvement in learning as reported by Dori and Belcher (2005) is compelling but primarily serves to validate the effort and funding expended in transforming the physics curriculum. It reflects the underlying imperative of universities to 'measure' new initiatives, to determine 'value' in tangible terms. However, the success of the TEAL Studio lies not in the student statistics collected over one or two years; rather, it exists in the fact that the entire physics curriculum has been transformed, including the physical environment in which it is taught. As a result, teachers are practising student-centred learning, enabling students to interact, collaborate, test, simulate, solve problems and undertake other activities that demonstrate deep engagement with the course content.

2.3.5 Augmenting the Learning Space Design Discourse

The Learning Studio at ANU and the TEAL Studio at MIT represent early examples of NGLEs that were developed to enable student-centred learning. The critical differentiator between these examples and other higher education classroom typologies is that they were conceptualised by academics in response to: a) their intention to foster a more student-centred approach to learning and, in the case of the MIT physics professors, change the curriculum to an explicit PBL model; and b) their perception that the intended student-centred learning approach was not possible in traditional classroom environments. The higher education learning space design discourse emerged largely in response to academics who were expected to report and publish outcomes associated with their teaching and learning innovations, which was further necessitated in light of the considerable investment in new infrastructure.

Facility managers, through their critical role in procuring space on campus, also became immersed in the discourse, further propelling interest in the development of NGLEs. As interest increased among universities, professional organisations endorsed by facility managers, along with architects, played a critical role in augmenting the discourse through the publication of conference themes, journal articles and workshop proceedings. These organisations included the Society of College and University Planning (SCUP) in the USA, the Tertiary Education Facility Managers Association (TEFMA) in Australia and the OECD.

The SCUP journal, Planning for Higher Education, published an article at the end of 2003 titled *'Creating Adaptive Learning Environments'* (Kopp, Seestedt Stanford, Rohlfing & Kendall, 2003), representing their first foray into the new discourse. Stephen Kopp et al acknowledge that the design of learning spaces on campus had been "predicated on faculty-centered instruction in the oral tradition" (2003, p. 12) but proceed to urge the community of architects and planners to redesign learning spaces to "create opportunities for active learning experiences that empower each student to engage, access and use resources in ways that support their learning process" (2003, p. 15). The first and second authors are academic leaders of faculty, highlighting the shift in the discourse on university planning from architects and planners, to incorporate educational practice by academics. In 2005, the SCUP international conference revelational theme was:

> *"Planning, Linking, Learning—reflecting the idea and ideal that planning is about linking all of the individuals and activities in the academic enterprise to advance learning. Planning should be viewed as a double helix connecting every part of the academic enterprise, with learning as the common purpose."* (SCUP, 2005).

The conference included numerous presentations from academics and architects sharing experiences of designing and teaching in NGLEs, placing the learning space design discourse firmly on the global map.

Similarly, in Australia, TEFMA members—typically facility managers working within universities—began sharing their experiences of developing NGLEs. Numerous examples were constructed between 2003 and 2005, including the ambitious Collaborative Teaching and Learning Centre (CTLC) at the University of Queensland, designed entirely for the purpose of implementing collaborative learning (refer chapter 6). The new CTLC became the destination for a major TEFMA workshop where examples of NGLEs were discussed and issues shared (Fisher, 2005). Facility managers acknowledged they did not have the educational expertise to develop NGLEs and recognised the vital role of academics in contributing to the new space typology.

In the United Kingdom (UK), the design of NGLEs was also entering the higher education planning vernacular with a particular focus on technology and learning. *Spaces for Learning: A Review of Learning Spaces in Further and Higher Education* (Alexi Marmot Associates & haa design, 2006) achieved wide readership, presenting a range of spatial characteristics that should be considered in designing 'spaces for learning'. Their schema encourages design qualities such as 'enterprising', 'creativity' and 'boldness' in an explicit attempt to shift the design of learning spaces away from the didactic, template-driven, institutional form that had dominated the university campus suite of learning spaces. Importantly, *Spaces for Learning* connects the design of learning spaces with educational technologies that were becoming increasingly omnipresent. It recognises that students often require access to technology within the formal classroom, as part of the shift towards student-centred learning, but it also observes that students are increasingly connected to mobile internet-enabled devices, further enabling independent and collaborative activities in the classroom.

The US-based organisation, Educause, rose to prominence during the mid-2000s through conference presentations and publications. Having previously focused exclusively on educational technology, contributing authors increasingly include 'spaces for learning' as a major theme (Dugdale, 2009; Johnson & Lomas, 2005; Lippincott, 2009; Long & Ehrmann, 2005). President and CEO of Educause, Diana Oblinger, led the way with two compelling publications. The first, *Educating the Net Generation* (Oblinger & Oblinger, 2005), provides an insightful compilation of issues surrounding the characteristics of a new generation of students. The text portrays a new generation of students as technology-savvy, collaborative, social and environmentally sensitive citizens, presenting a significant generation gap between students and academics. Student Carie Windham's compelling comparison between her approach to technology and that of her professor exemplifies this generation gap:

> *"He preferred the newspaper over CNN.com, the weatherman over Weatherbug, and face-to-face visits over email exchanges. He dusted off his journals from the 1980s and flipped through their*

Table 3

Aligning Net Gen Characteristics, Learning Principles, Learning Spaces and IT Applications, adapted from Brown (2005).

Net Gen Trait	Learning Theory Principles	Learning Space Application	IT Application
Group activity	Collaborative, cooperative, supportive	Small group work spaces	IM Chat: virtual whiteboards; screen sharing
Goal and achievement orientation	Metacognition: formative assessment	Access to tutors, consultants and faculty in the learning space	Online formative quizzes; e-portfolios
Multitasking	Active	Table space for a variety of tools	Wireless
Experimental: trial and error	Multiple learning paths	Integrated lab facilities	Applications for analysis and research
Heavy reliance on network access	Multiple learning resources	IT highly integrated into all aspects of learning spaces	IT infrastructure that fully supports learning space functions
Pragmatic and inductive	Encourage discovery	Availability of labs, equipment and access to primary resources	Availability of analysis and presentation applications
Ethnically diverse	Engagement of preconceptions	Accessible facilites	Accessible online resources
Visual	Environmental factors: importance of culture and group aspects of learners	Shared screens (either projector or LCD): availability of printing	Image databases; media editing programs
Interactive	Compelling and challenging material	Workgroup facilitation; access to experts	Variety of resources; no ‘one size fits all’

pages, and he actually knew how to load one of those microfiche machines on the second floor of the university library. He represented for me, a world I could scarcely remember … I am a member of the Net Generation. I've surfed the Web since the age of 11, and it has increasingly taken over every facet of my personal and academic existence." (Windham, 2005, p. 5.2)

The second publication, titled *Learning Spaces* (Oblinger, 2006), builds upon the learning environment theme that was introduced in the first text. The *Learning Spaces* text sagely draws upon the variety of issues identified as inextricably linked to the design of new types of learning spaces, including designing for student-centred learning (Dittoe, 2006), understanding how students learn (Milne, 2006), educational technology (Brown & Long, 2006) and environmental psychology (Graetz, 2006). The prominent message from this publication is the complexity of issues and multiplicity of disciplines required to design NGLEs. Technology expert, Malcolm Brown (2005), demonstrates the early convergence of net generation traits, pedagogy, space and technology in the following table (see Table 3).

The Net Gen characteristics as outlined by Brown highlight the generation gap between traditional forms of teaching and learning and the emergence of NGLEs, augmented through the mobility and accessibility of technologies available to students. As students increasingly began carrying hand-held technologies that provided access to a world of knowledge, they no longer had to rely on teachers feeding a limited curation of content. With the advent of widespread WIFI networks on campus, students gained access to an array of resources of their own bringing into the classroom. Although technology is not the key focus of this study, the advent of students carrying mobile devices is acknowledged as a pivotal change in the relationship between teacher and student, impacting student expectations of what they can (or should be able to) do in the classroom.

This section has detailed how the learning space discourse has emerged from initial reports of experimental examples of NGLEs to a worldwide audience. The multidisciplinary engagement of academics, facility managers, architects and others, through professional bodies such as TEFMA, SCUP and Educause boosted interest in the development of NGLEs as a new space typology to foster and enable more effective teaching and learning processes. The next section will demonstrate the criticality of post occupancy evaluation in the ongoing development of NGLEs.

2.3.6 Evaluation of New Generation Learning Environments

The emergence of NGLEs has driven demand for evaluation, in order to demonstrate tangible outcomes and legitimise efforts to design and build them. Environmental psychologist, Craig Zimring and Architectural sociologist, Janet Reizenstein, broadly define post occupancy evaluation (POE) as "an examination of the effectiveness for human users of occupied design environments" (1980, p 429). In the context of educational environments, Wes Imms, Ben Cleveland & Kenn Fisher define POE as the process of "improving future practice by looking back (auditing/appraisal), looking to the future (improvement and prediction/analysis) and looking within (valuing/judgment)" (2016b, p11).

In 2006, following the early development of NGLEs as outlined earlier in this section, the Australian Learning and Teaching Council, an Australian Commonwealth Government funding body, invested in research to capture enhancements in the teaching and learning process related to the emergence of NGLEs. One of the first learning space research projects to be funded was '*Designing Next Generation Places of Learning: Collaboration at the Pedagogy–Space–Technology Nexus*' at the University of Queensland (Radcliffe, Wilson, Powell & Tibbetts, 2006). This project incorporated two major symposiums in 2007 and 2008, the second of which culminated in the presentation and subsequent publication of post occupancy evaluations of NGLEs from a range of Australian universities (Radcliffe, Wilson, Powell & Tibbetts, 2009). A major outcome of the NGLE symposia and publication by Radcliff et al. (2008; 2009) is the Pedagogy–Space–Technology (PST) Framework for Designing and Evaluating Learning Places, which highlights the extrinsic link between the three constructs:

> *"Each of the three elements, pedagogy, space and technology, influence each other in a reciprocal fashion … 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."*
> (Radcliffe et al., 2009, p. 14)

The Pedagogy-Space-Technology (PST) project sought evaluations from seventeen examples of NGLEs, through a series of questions which asked: What is it? Why is it? What happens here? How is the space used? How is technology used? How was the facility evaluated? What were the lessons learnt? There was an explicit goal to define teaching and learning objectives in order to "determine whether or not such [learning] behaviours are observed and which aspects of the space and technology are seen to enable, encourage and empower these types of teaching and learning activities" (Powell, 2009, p29). These questions provided an interesting framework for the case studies, however there was a lack of rigour to the application, particularly in relation to how and what was evaluated in their respective NGLEs.

In the UK, the Joint Information Systems Committee (JISC) organisation also funded a major research project with a focus on developing a 'conceptual Framework for Evaluating Learning Spaces (FELS)' (Pearshouse et al., 2009, p. 5). While the research methodology in this project demonstrates rigour, the framework becomes overly complicated, raising questions as to who within the university would be suitably qualified to conduct such an evaluation. The simple foundation questions of why, what and how, are required to be broken down into 32 sub-categories, which in turn are further dissected. While the FELS framework is rigorous, it demands specialist skills and knowledge that may limit an institution's ability to implement.

In consulting with universities that had experimented with the creation of NGLEs, Pearshouse et al. "found that while most institutions recognised a need to evaluate teaching and learning within a space, the main drivers for evaluation were to satisfy management that the spaces were being used and they were well-liked by students" (2009, p. 30). This highlights a key tension in the discourse: NGLEs require evaluation to assess the degree to which new classrooms are enabling or inhibiting effective teaching and learning processes, yet effective teaching and learning is rarely defined in the originating brief. It is not always clear when evaluating each classroom what the teacher is intending students to be able to do, and whether or not students are using the space in ways that are aligned with the teacher's pedagogical intentions.

Educator, Nicolette Lee and designer, Stella Tan, undertook a funded research project representing a collaborative partnership between three Australian institutions and three trial evaluations (2011). They identified several challenges in the field of learning space evaluation, including:

> *"a lack of resourcing dedicated to comprehensive evaluations; sensitivity of evaluation processes and findings; a tendency to present spaces positively and without contextual information; limitations in understanding about the purpose and value of evaluation; limiting assumptions about the potential for input from a variety of stakeholders, and; the complex nature of evaluation itself"* (Lee & Tan, 2011, p.2).

Lee and Tan make the observation that "there is a lot riding, both individually and institutionally, on spaces being successful", leading to concerns that institutions appear to be reluctant to share the 'warts and all' findings of evaluation. They draw an optimistic conclusion that "as the field [of learning space evaluation] matures" education institutions will set aside their competitive drivers and develop communities of practice that are incentivised to share knowledge (2011, p.10).

Since 2011, the development of learning space evaluation has unfortunately failed to significantly advance, particularly in the context of higher education. Cleveland and Fisher present a literature review on the status of learning space evaluation in both higher education and school settings (2014). They did not find any further development of the field, concluding:

> *"evaluations that attempt to assess the effectiveness of physical learning environments in supporting pedagogical activities are in their infancy and require further development. As indicated by Radcliffe (2008), Powell (2008), Pearshouse et al. (2009) and Lee and Tan (2011), more studies are required in order to develop rigorous methodologies and methods that can be confidently employed to assess the effectiveness of physical learning environments in supporting desired teaching and learning practices, activities and behaviours."* (Cleveland and Fisher, 2014, p24.)

In an explicit attempt to reenergise the topic, the University of Melbourne curated a series of PhD presentations and papers, focusing on the evaluation of learning spaces, including the author of this study (Imms et al., 2016). The accumulative argument undeniably favours greater uptake of evaluation of innovative learning spaces across school and higher education sectors, with many PhD candidates presenting new evaluation propositions and methodologies. Imms et al cite the importance of interdisciplinary approaches to evaluation (2016), echoing Lee and Tan's findings that evaluation should be embedded within communities of practice (2011). The potential for new evaluation methods to arise from the University of Melbourne is still in play (Imms et al., 2016). However, there are ongoing concerns that the complexity of evaluation, in itself, is a deterrent for implementation.

Malcolm Brown et al. present another comprehensive evaluation tool called the Learning Space Rating System (LSRS) with the objective of measuring "progress toward designing learning spaces that support active learning and engagement" (Brown et al., 2017, p.5). This rating system is focused specifically on the evaluation of formal classrooms, divided in two parts: 1) Campus context, Planning and Support considerations; and 2) Environment, Furnishings, Layout and Technology. It is based upon a credit point system whereby the evaluator scores 1 – 2 points for each of forty-four criteria with evidence to be presented for validation of each criteria. This represents another thorough method for evaluating learning spaces, including institutional factors such as alignment with university strategy, professional development support for academics and compatibility with timetable systems. The 'environment' criteria incorporates indoor environment quality and elements such as seating density, furniture mobility and accessible technologies within the classroom.

However, there are two key concerns with the LSRS evaluation tool. The first is the lack of pedagogical consideration, apart from one ambiguous directive to "consult literature, online resources and other experts in the field" (Brown et al., 2017, p.16). There is no explicit intention within the tool to evaluate the type of teaching and learning that may take place. The second weakness is that the evaluation demands considerable time and cost to implement, questioning the likelihood of universities investing in this effort. While the time and effort required to implement a POE is not a criticism of the tool itself, there are concerns that the effort may not be valued by institutions and will inhibit implementation.

Scott-Webber, Strickland & Kapitula (2013) report on the implementation of a bespoke POE tool developed for Steelcase Education Solutions (SES) and applied to three NGLEs, which the authors refer to as 'active classrooms' and where SES furniture was present. Their methodology focused on "twelve identified student engagement factors" (2013, p.30) with students self-reporting their perceptions of levels of engagement. Students reported their actual experience in the NGLE compared to their assumed experience of a traditional classroom as a result of viewing images of classrooms where rows and columns of tables and chairs are facing the same direction.

One key finding indicated that "the majority of students rated the new [NGLE] classroom higher or better than the old [traditional] classroom on each of the [twelve engagement] factors" (Scott-Webber et al., 2013, p.33). Another finding indicated that students believed the NGLE "contributed to a moderate to exceptional increase in their engagement in class, ability to achieve a higher grade, and increase in motivation to attend class." (Scott-Webber et al., 2013, p.33) Despite the obvious perception of bias due to Steelcase's inherent investment in the findings, this does represent an alternative form of POE which focuses on student perceptions of their experience of learning within a NGLE, rather than targeting the physical environment and other institutional factors. However, as with all POE methods described here, they are time consuming and require specialist knowledge to prepare, implement and analyse.

This exemplifies a critical tension surrounding POE. There is significant consensus among POE advocates that evaluation of NGLEs should be undertaken in order to continually improve the design of future NGLEs (Cleveland & Fisher, 2014; Lee & Tan, 2011; Zimmerman & Martin, 2001; Zimring & Rosenheck, 2001). However, as Lee and Tan (2011) and Cleveland and Fisher (2014) indicate, effective POE exemplars are uncommon. The evaluation tools developed specifically for NGLEs are fraught with difficulty as a result of being too complex or time consuming to implement.

As an alternative to the forms of POE described here, but with the intention of demonstrating the benefits of student-centred learning, Freeman et al (2014) undertook a meta-analysis of 225 studies that reported on student performance in science, technology, engineering and maths (STEM) subjects. In their study Freeman et al focused on literature that reported comparisons between STEM subjects delivered in lectures versus ‘active learning’ modes. Their findings indicated that “average examination scores improved by 6% in active learning situations, and that students in classes with traditional lecturing were 1.5 times more likely to fail than were students in classes with active learning” (Freeman et al., 2014, p. 8410). While the specifics of the physical environment are not detailed, this research is compelling, especially when contextualised with other POE methods and outcomes. Notwithstanding the concerns surrounding POE of NGLEs, interest in the ongoing development of NGLEs continues to prosper. The next section will outline recent literature on the progress of NGLEs across the world.

2.3.7 Developing New Generation Learning Environments

The Horizon Report is an annual publication which documents future trends in higher education with a particular focus on educational technologies and their timeline for adoption (Adams Becker et al, 2018). It represents an interdisciplinary community of practice comprising approximately sixty academics across the world, who engage in an iterative debate to agree upon trends set to impact the global higher education sector. Since its inception in 2007, the *Horizon Report* has pointed to several significant technological developments in education, such as the impact of social media on learning, game-based learning, Massive Open Online Courses (MOOCs) and more recently, artificial intelligence. As an indicator to the significance of NGLEs, the *Horizon Report* has documented the trend of 'Redesigning Learning Spaces' each year since 2015. Institutions are not only stating the shift away from teacher-centred to student-centred practice, but are coupling this vision with an awareness of the criticality of how space is designed to align with new pedagogies. According to Co-Principal Editor of the *2015 Horizon Report*, Larry Johnson:

> *"As higher education continues to move away from traditional lecture-based programming and to more hands-on scenarios, university classrooms will start to resemble real-world work and social environments that facilitate organic interactions and cross disciplinary problem solving"* (Johnson et al., 2015, p18).

Samantha Adams Becker, Co-Principal Editor of the *2018 Horizon Report*, demonstrates an evolving perspective on the redesign of learning spaces by acknowledging the application of advanced technologies that relate to real-world experiences:

> *"Educational settings are increasingly designed to support project-based interactions with attention to greater mobility, flexibility, and multiple device usage. Some [institutions] are exploring how mixed-reality technologies can blend 3D holographic content into physical spaces for simulations, such as experiencing Mars by controlling rover vehicles, or how they can enable multifaceted interaction with objects, such as exploring the human body in anatomy labs through detailed visuals"* (Adams Becker et al., 2018, p20).

In the 20 years since the first experimental NGLEs were built (Trevitt, 1999; Dori & Belcher, 2005; Fisher, 2005), a plethora of case studies and publications of positive teaching and learning experiences relating to NGLEs has emerged, viewed through a variety of lenses.

Boddington & Boys (2011) present a uniquely UK and cross-disciplinary perspective, linking the threads of pedagogical opportunities, institutional factors, evaluation and how design theory may impact the design of NGLEs. This text demonstrates linkages between pedagogy and environmental psychology (Melhuish, 2011), a conjuncture that the author of this study observed as being notably disconnected throughout the late twentieth century.

Educator, Kym Fraser (2014) presents a compendium of institutional factors affecting the development of NGLEs, including the adoption of mobile technologies (White, Williams & England, 2014) professional development of academics (Hall-van den Elsen & Palaskas, 2014), the teacher's perspective (Ling & Fraser, 2014), design (Hadgraft & Dane, 2014) and evaluation (Germany, 2014). This comprehensive text presents as a useful 'how to' guide for developing NGLEs. Despite the positive sentiments throughout, Fraser states that significant research is still required to fully understand the impact of NGLEs on student learning outcomes, concluding:

> *"We know that students like the spaces, but we don't know if the spaces alone are effective in improving student learning or if the spaces in combination with changed pedagogic practices and/or curriculum design improve learning"* (Fraser, 2014, p.333).

Fisher and Newton (2014) take a novel approach by aligning graduate competencies with the design of NLGEs. Engineers Australia cite ten graduate attributes, including the ability to work in teams, communicate effectively and applying systems thinking to problem solving (Bradley, 2006). Fisher and Newton link these attributes to the design of three Australian engineering NGLEs, describing the affordances of space in developing the required student competencies. Despite these unique insights Fisher and Newton conclude:

> *"The more we learn about the inter-relationships between teaching, learning, technology, physical and virtual learning environments, the more we realise we need to continue to deeply research this complex topic further"* (2014, p. 919).

As the groundswell of interest in NGLEs has presented in the literature, there is a sense that researchers are acknowledging how much more there is to learn on the topic. The University of Melbourne is demonstrating their commitment to this endeavour, through the establishment of the Learning Environment Applied Research Network (LEaRN), a dedicated research cluster comprising a multidisciplinary collection of academics from architecture and education and supported through the achievement of a number of federally funded research grants. Although most of their research is contextualised within schools, they are building a strong cohort of PhD students and are collectively making significant headway into better understanding of issues relating to the design of NGLEs (Cleveland, 2018; Bradbeer et al, 2017; Imms & Byers, 2017).

2.4 CHAPTER CONCLUSION

This chapter has presented a critical review of literature relating to three distinctly different discourses:

1. student learning research in higher education, including an historical overview of its development and the extant tensions between the practice of student-centred learning and traditional classroom environments;
2. environmental psychology and the effect of designing environments to elicit specific human behaviours; and
3. the emergence of a new discourse to coincide with the development of new generation learning environments and the impetus for post occupancy evaluation to demonstrate the benefits of NGLEs.

Based upon the assertions of environmental psychology research, that the physical environment does impact human behaviour, this study contends it is possible to design learning environments to enable human behaviour associated with student-centred learning. Despite the fields of student learning research and environmental psychology almost intersecting during the 1970s and 1980s, and the potential benefits of doing so, the discourses have remained largely in parallel.

The emergence of NGLEs in higher education has been driven by higher education teachers with an awareness that implementing student-centred learning is severely constrained in traditional classrooms. This has generated demand for a new classroom typology initiated by educators, implemented by facility managers and architects and utilised by teachers and students. In so doing, a new discourse relating to the multidisciplinary discourse of 'learning space design' has emerged. In this discourse, pedagogy, technology and space are presented as key elements, with pedagogy providing the initial and consistent focus of each NGLE.

This study contributes to the learning space design discourse in a number of critical and fundamental ways. First, it unites the discourses of 'student learning research' and 'environmental psychology' to promote a process for designing learning environments through an understanding of human behaviour that is associated with student-centred learning. Second, an examination of the literature pertaining to 'effective teaching and learning' (a subset of student-centred learning to be detailed in Chapter 3), reveals common characteristics that have implications for student learning behaviour and classroom design, culminating in the

Chapter 3: Effective Teaching and Learning Framework

3.0 THE ESSENTIAL ELEMENTS OF EFFECTIVE TEACHING AND LEARNING

As reported in chapter two, the literature review of ‘student-centred learning’ reveals a distinct theoretical and practical domain referred to as ‘effective teaching and learning’. The term refers to an approach to teaching and learning that is holistically dedicated to enabling students to foster a deep approach to learning. In dissecting the effective teaching and learning literature, a theoretical schema emerges that fundamentally guides the methodological and analytical framework of this study. Key concepts in the literature surface, resulting in profound implications for student learning behaviour and consequently the revelation of key spatial characteristics that foster desired teaching and learning behaviours. The effective teaching and learning discourse presents explicit and implicit clues as to the teaching and learning processes that may occur in the classroom, through the practice of pedagogies such as collaborative learning, problem-based learning (PBL) and peer-to-peer learning (to be collectively referred to in this chapter as ‘innovative pedagogies’). It prompts the question, What does effective teaching and learning in the classroom look like?

This chapter dissects each of the ‘essential elements’ of effective teaching and learning, as described consistently throughout the discourse, revealing actions and behaviours by teachers and students that contribute to effective teaching and learning, refer Table 1. Each ‘element’ concludes with a summary of desirable teaching and learning behaviours expected to be made possible in a NGLE. These behaviours are presented as holistic actions rather than fine-grain behaviours. In other words, rather than anticipating the minutia of behavioural possibilities, the schema rationalises broad behaviours such as the possibility of students interacting with each other, moving around the room or capturing digital content. Each element will be described in relation to relevant literature across the fields of student learning research and environmental psychology, as well as presenting the behavioural possibilities for teachers and students in the practice of effective teaching and learning.

Using the term ‘possible’ is crucial in describing the essential elements, to identify that the behaviour “can be done, it may happen” (Oxford University Press, 2000). Not all desirable teaching and learning behaviours will necessarily be enacted in every teaching and learning encounter. However, by creating a physical NGLE in which the desirable teaching and learning behaviours are made ‘possible’ as a result of the affordances of the room, it is hypothesised that effective teaching and learning will be realised. At the end of this chapter, the essential elements and possible teaching and learning behaviours together form the Effective Teaching and Learning Behavioural Framework.

Table 1 (duplicated from Chapter 1)

Essential Elements of Effective Teaching and Learning

Effective teaching and learning in formal higher education classrooms...	References:
1. encourages the teacher to understand the student's perspective and build meaningful relationships with students	Entwistle, 2009; Laurillard, 2002; Marton & Booth, 1997; Prosser & Trigwell, 1999; Ramsden, 2003; Rogers, 1969
2. is a social process whereby knowledge is socially constructed	Dewey, 1897, 1961; Garrison & Archer, 2000; Laurillard, 2002; Lave & Wenger, 1991; Piaget & Inhelder, 1969; Vygotsky, 1978
3. fosters a deep approach to learning that encourages student independence	Dewey, 1961; Entwistle, 1984; Hounsell, 1997; Marton & Saljo, 1997; Rogers, 1969
4. promotes student activity and engagement with content	Biggs & Tang, 2007; Chickering & Gamson, 1987; Entwistle, 2009; Hounsell, 1997; Prosser & Trigwell, 1999; Ramsden, 2003; Shuell, 1986; Skinner, 2010
5. is contextualised & relevant; teachers have an awareness of student prior learning	Biggs & Tang, 2007; Entwistle, 2009; Hounsell, 1997; Laurillard, 2002; Prosser & Trigwell, 1999; Ramsden, 2003; Rogers, 1969; Shuell, 1986; Skinner, 2010
6. involves the teacher providing effective and timely feedback to students	Biggs & Tang, 2007; Chickering & Gamson, 1987; Entwistle, 2009; Hounsell, 1997; Laurillard, 2002; Prosser & Trigwell, 1999; Ramsden, 2003

3.1 ESSENTIAL ELEMENT 1: Effective Teaching and Learning Encourages the Teacher to Understand the Student's Perspective and Build Meaningful Relationships with Students

3.1.1 Context

Every teaching situation is different; each learning encounter is unique. Effective teaching and learning encourages the teacher to practise a degree of agility in the classroom, to enable change or adapt the learning encounter in response to the perceived perspective of the student and the student's awareness of their learning situation. This is supported by educators Michael Prosser and Keith Trigwell who describe 'good teaching' as a 'continuous process of looking at the learning and teaching situations from the perspective of the student and adjusting the teaching in the light of this continuous monitoring' (1999, p. 168).

Similarly, Ramsden proposes that teaching should involve "learning from students" and "imagining oneself as the student" (2003, p. 98). He further extrapolates that "good teaching is open to change; it involves constantly trying to find out what the effects of instruction are on learning, and modifying that instruction in the light of the evidence collected" (2003, p. 98).

Marton and Booth present a definition of pedagogy that describes how:

> *"teachers mold (sic) experience for their students with the aim of bringing about learning, and the essential feature is that the teacher takes the part of the learner, sees the experience through the learner's eyes, becomes aware of the experience through the learner's awareness."* (1997, p.179)

By approaching the classroom encounter as a shared experience, it becomes possible for the teacher to better understand the student perspective and build meaningful relationships with students, developing mutual trust and respect.

3.1.2 Teaching and Learning Practice

The ability of the teacher to understand the student perspective in each unique learning encounter is enhanced by the teacher being able to interact with students, either verbally or visually. Visual interaction aligns with Gibson's definition of 'perception', the "meanings of perceived events and sequences" incorporating the "range of social meanings, facial expressions, gestures and actions between persons" that, in an educational context, may signify when a teacher should intervene to assist students or adapt the learning encounter (Gibson, 1950, p. 199). Meaningful transactions between teacher and students, where the teacher can make positive eye contact with students and/or engage in dialogue, supports the teacher's perception of engagement and understanding exhibited by each student. The teacher may then adapt aspects of the learning encounter in response to their awareness of how the content is being understood (Prosser & Trigwell, 1999). Understanding and monitoring the student perspective becomes possible when the teacher can easily move around the classroom, accessing all students equally.

Compare this experience to one where the teacher is fixed behind a podium or on a raised platform, physically disconnected from the students and too far away to 'read' students' faces for clues as to their perspective and experience. Hall (1970) and Lawson (2001) describe the distance in this situation as 'public distance' whereby the lecturer is physically separated from the audience to the degree that there is a tendency to "ignore other people in space" (Lawson, 2001, p. 119). When the teacher responds warmly to students, for example through positive eye contact, facial expressions or direct conversation, students are more likely to develop a meaningful relationship with the teacher. An example of this exists in the Horowitz and Otto study (1973) where one of the noted changed behaviours in students learning in the 'alternative classroom' was their increased consultation with the teacher outside of class. This demonstrates not only considerable engagement by the students with the topic, but that a meaningful relationship developed between the teacher and the students—a factor that was less noticeable in the cohort learning in the traditional classroom (Horowitz & Otto, 1973).

The application of innovative pedagogies may necessitate the teacher being able to facilitate student activities in class and interact with students in different ways. For example, the teacher may need to address the whole class in order to explain a task or provide important information. The teacher may also need to interact with each small group, to evaluate their progress or answer any questions. It may also be necessary for the teacher to interact directly with an individual student, separately to the group.

Effective teaching and learning may be demonstrated as a harmonious relationship between teacher and students—exhibited, for example, by equitable access to educational technologies by both teacher and students. Technologies in traditional spaces have historically been limited to the lectern or the whiteboard at the front of the room, signifying the teacher's domain and expressing an invisible line of authority. Through the implementation of innovative pedagogies, students are often encouraged to use technologies in the classroom, such as writeable surfaces, pinboards and digital screens, as well as bringing their own technologies into the classroom. Students being able to access all technologies in the room helps breaks down any perception of an authoritarian presence in the room, paving the way for teacher and students to build meaningful relationships.

3.1.3 Summary

Therefore, when encouraging the teacher to understand the student's perspective and build meaningful relationships with students, it should be possible for:

- the teacher to move around the room and access all student equally and equitably

- the teacher to engage with students individually, in small groups or as a whole cohort

- the teacher and students to access the same educational technologies

3.2 ESSENTIAL ELEMENT 2: Effective Teaching and Learning is a Social Process Whereby Knowledge is Socially Constructed

3.2.1 Context

Garrison and Archer (2000) describe the social nature of learning in a higher education context as 'collaborative constructivism', citing Dewey as a crucial influence. They assert that "meaning and knowledge are constructed and reconstructed from a complex mosaic of social experiences, and it is this process of personal construction that ensures continuous development" (2000, p. 11). Garrison and Archer offer a 'transactional perspective' whereby they see the learning process beginning with 'constructive collaboration'. As meaning and understanding are established, learners develop more complex cognitive abilities (Garrison & Archer, 2000).

Laurillard similarly draws inspiration from constructivism as a social process, presenting a perspective of teaching and learning that is grounded in "a continuing iterative dialogue between teacher and student", a concept Laurillard labels the 'conversational framework' (2002, p.71). It is interesting to note that while Laurillard presents the conversational framework as a situated experience "between the learner and the world, and mediated by the teacher", incorporating a range of activities that occur within the "teacher's constructed environment", there is still an absence of awareness of the effect of the physical setting on the student learning process (Laurillard, 2002, p.86-87).

An alternative educational schema is proposed by social anthropologist Jean Lave and educational theorist Etienne Wenger, who present the concept of 'legitimate peripheral participation' (1991). This concept describes participants in communities of practice as "moving towards full participation" to master knowledge and skills (1991, p.29). They describe teaching and learning activities as not being situated in isolation, but that learners are part of a larger community that transcends the classroom, the campus and the home. Students exist as part of a learning community that becomes a shared experience in the classroom: "As an aspect of social practice, learning involves the whole person; it implies not only a relation to specific activities, but a relation to social communities—it implies becoming a full participant, a member, a kind of person." (Lave & Wenger, 1991, p. 53)

Peter Lippman (2010) extrapolates from Lave and Wenger (1991) to describe the three core levels of participation in the classroom as 'peripheral', 'guided' and 'full'. In this schema peripheral engagement is the student's experience at a distance (listening to/watching others). Guided engagement involves working collaboratively with others or discussion with the teacher, while full engagement is considered the total immersion of the individual in completing a task (Lippman, 2010). While Lippman's schema is contextualised in schools, there is an unequivocal synergy with the range of innovative pedagogies practised in higher education. 'Peripheral' participation may represent the experience of the teacher addressing the whole class, for example, while 'guided' and 'full' participation is symptomatic of socially embedded, collaborative practices.

3.2.2 Teaching and Learning Practice

Effective learning as a social process in the classroom is exemplified by the ability of students to directly discuss, interact and engage with each other, regardless of how well students personally know each other. Discussion and interaction can take many forms: in response to an artefact or something 'discovered', a topic of inquiry, planning for a collaborative assignment, brainstorming ideas, role playing and so on. Students can situate their interactions by sitting, standing, moving around or even lying on the floor. The learning encounter may even present the possibility of students temporarily leaving the room.

Passive or peripheral engagement should not be discounted as a legitimate learning experience for short durations, as it may augment future social ('full') interaction (Lave & Wenger, 1991; Lippman, 2010). Students come to the learning encounter with a variety of prior learning experiences, biases and predilections, which may enable or inhibit immediate engagement with their peers. The social process of learning becomes increasingly participatory as students build relationships with peers and the teacher. These developing levels of engagement have implications for the distances between students, as their interactions move towards 'full' engagement.

Cultural anthropologist Edward T. Hall (1970) categorises a taxonomy of human distance in space as 'intimate', 'personal', 'social' and 'public', identifying the physical distance commensurate with each category. Intimate space exists within 0.5 m, personal space within 1.2 m and social space within 4 m, after which it becomes public space (Lawson, 2001). Therefore, in a classroom environment, students should initially be situated at a 'personal' to 'social' distance, to enable activities such as discussion, brainstorming and content sharing. The opportunity for 'intimate' distance increases as students become fully engaged in side-by-side tasks such as content-creation, problem-solving and analysis.

The environment must establish the potential for a variety of social interactions to occur at varying levels of engagement. Therefore, the environment's capacity to enable a variety of social processes is a key attribute of NGLEs.

3.2.3 Summary

Therefore, to enable learning as a social process where knowledge is socially constructed, it should be possible for:

- students to interact at a 'personal' or 'social' distance as tasks are being established

- students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance

- different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.

3.3 ESSENTIAL ELEMENT 3: Effective Teaching and Learning Fosters a Deep Approach to Learning That Encourages Student Independence

3.3.1 Context

Student choice is a recurring theme in the discourse on effective teaching and learning, presenting the idea that providing students with choices of learning style, topic or assignment format may lead to greater independence in the learning process. The converse may also be true, where a student's lack of choice breeds dependency upon the teacher to instruct at every level, removing any opportunity for the student to develop initiative and critical thought. Ramsden asserts that student enjoyment of learning is greater when presented with choices, stating that "good teaching fosters this sense of student control over learning and interest in the subject matter" and that permitting "a degree of student control over learning can thus accommodate individual differences in preferred ways of reaching understanding" (Ramsden, 2003, pp. 97–98).

In this sense the notion of independence can be related back to Dewey and his belief that instilling independence in children appropriately prepare them for a life of decisions, problem solving, negotiation, invention, creativity and discovery (Dewey, 1897, 1961, 1990). Learning should be viewed as a life-long endeavour, either formally or informally. However, students need to be given the freedom to experiment, make mistakes, fail and learn from those experiences (Rogers, 1969). This is part of the journey to developing a deep approach to learning, and consequently developing initiative and independence.

The link between learning independence and environmental behaviour is implicit in concepts of 'affordance' and 'freedom'. The student's freedom to manipulate the physical setting is in part determined by their initiative and sense of independence engendered by the teacher, but also by the affordances of the environment. Gifford (2002) presents Gibson's concept of 'affordance' as the environmental cues that enable the occupant to instantly detect its function. For example, a round table surrounded by four chairs may be instantly recognisable as a setting at which discussion can take place. The same setting may simultaneously enable a competitive board game to play out, or individual test papers to be completed. A lecture theatre setting of tiered seats all facing the lecturer's podium provides environmental cues that the occupants are to sit and listen to the lecturer but does not preclude the audience from performing as a choir. Even in the most limiting of environments, multiple affordances are likely to exist; it is incumbent upon the occupants to recognise the opportunities and possibilities afforded by the environment.

Freedom of choice within an environment can be linked to the occupant's sense of ease and security (Proshansky, Ittelson & Rivlin, 1970c). These feelings may relate to the teacher's encouragement to experiment, try new things and test new ideas, even if this means sometimes failing. The level of comfort required for students to recognise the choices in their surroundings may not be instantly evident, but will mature as their relationships with the teacher and peers develops. Carl Rogers acknowledges that "creativity blossoms in an atmosphere of freedom", and that:

> *"if a learner is to become independent and self-reliant he must be given opportunities to make his own judgements and his own mistakes but to evaluate his own behaviours, come to his own conclusions and decide on the standards which are appropriate for him"* (1969, p. 163).

3.3.2 Teaching and Learning Practice

Fostering a deep approach to teaching and learning may involve the teacher providing students with the freedom to manipulate their classroom environment, taking advantage of the classroom's affordances. For example, this might include moving to a quiet corner of the room to read, or cluster some chairs around a writeable surface for an intense brainstorming session. The freedom to manipulate the classroom assists students achieve optimal conditions for a deep learning experience, such as a quiet atmosphere for prolonged focus and less disruption, or, a group setting with access to educational technologies that enables continuous workflow without disruption. Students should not have to wait for the teacher to give permission to manipulate the room, although there may be 'rules' associated with returning the room to its original layout.

In this sense, students may be encouraged to work at their own pace, either individually or within a group. Notwithstanding task-oriented deadlines (e.g. you have ten minutes to build a self-supporting model using paper), assignments, project-based and problem-based work often extend over several weeks, meaning that different students will approach their learning tasks in different ways. This establishes the possibility that students in a single classroom may be undertaking different tasks at the same time. This has considerable implication for the design of a NGLE, suggesting the need for a variety of furniture arrangements and educational technologies. For the teacher, the variations in student pace and learning activities mean they will need to regularly interact with students/groups to monitor progress and facilitate problems.

The shift towards independence occurs when students take ownership for their learning progression. The freedom to make decisions in relation to the arrangement of the classroom furniture and conditions, as well as working at a pace appropriate to their capabilities, leads students towards less dependence upon the teacher. Students may be able to help answer each other's questions, such as has been described in the Flipped Learning concept.

3.3.3 Summary

Therefore, when fostering a deep approach to learning and encouraging student independence, it should be possible for:

- students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions

- students to work at their own pace

- different students to engage in different activities at the same time

3.4 ESSENTIAL ELEMENT 4: Effective Teaching and Learning Promotes Student Activity and Engagement

3.4.1 Context

Promoting student-centred activity and engagement is the central tenet of effective teaching and learning; for without student engagement you cannot have effective learning. Student engagement in the classroom is exemplified by their demonstrated interest in a subject, the activities employed to learn about the topic, their intrinsic motivation to learn and the way they approach the learning process. For example, educator Paul Ramsden places importance on teaching having "the ability to make the material of a subject genuinely interesting, so that students find it a pleasure to learn it" (2003, p. 93). This suggests positive implications for student motivation to learn, although Ramsden saliently reminds us that "student activity does not itself imply that learning will take place" (2003, p. 113). In other words, activity should relate to the context and relevance of the content to be learned, for it to be meaningful and interesting. According to educational psychologist Thomas Shuell:

> *"If students are to learn desired outcomes in a reasonably effective manner, then the teacher's fundamental task is to get students to engage in learning activities that are likely to result in their achieving these outcomes, taking into account factors such as prior knowledge, the context in which*

the material is presented, and the realisation that students' interpretation and understanding of new information depend on the availability of appropriate schemata. Without taking away from the important role played by the teacher, it is helpful to remember that what the student does is actually more important in determining what is learned than what the teacher does" (1986, p. 429).

3.4.2 Teaching and Learning Practice

A key concept in Shuell's argument, and in general the student-centred learning discourse, is a focus on what students 'do' to advance their learning. As a verb, 'doing' implies 'action' and 'activity'; in the context of student-centred learning this implies student action and learning activity. This is distinct from passive activities such as 'listening' and 'watching', which may have their place for short durations. 'Doing' activities relevant to the learning objective, promotes deep engagement with the concept or content to be understood and learned. They enable the student to be deeply immersed in the learning process, increasing the likelihood of retaining that knowledge and creating meaningful linkages to related concepts. A deep approach to learning in the classroom may be illustrated through the student's continuous engagement with the subject matter, which may take highly active forms such as debating, hypothesising and critiquing, or less active tasks such as reflecting upon feedback, watching a short presentation or listening to others debate.

Engagement may prevail as an individual activity or in collaboration with others; however, the key concept is that engagement implies an authentic and sustained interest in the content, which will often be active and dynamic, but may also be reflective and passive. The degree to which learning activities can be implemented by students and teachers is significantly influenced by the affordances and constraints of the physical setting. Therefore, NGLEs should have furniture settings that support group work, but still support individual tasks.

The physical environment is likely to enhance student activity and engagement when educational technologies seamlessly connect to online environments and devices brought into the classroom by students, enabling sharing of content created in class. The 'products' of student interactions on digital screens, writeable surfaces and student devices constitute learning traces that could potentially have ongoing benefit to teachers and students. Student activity and engagement is consolidated when the product of student interactions and the teacher's presentation material is easily captured and shared, and even more so when such interactions can continue either online or outside the classroom. With multiple groups working in one space, it may be necessary to provide multiple sets of educational technologies and for those technologies to be distributed equitably around the room. This would help avoid any perception of inequality in the classroom as a result of some students being located in close proximity to resources and other students not being located close to resources.

3.4.3 Summary

Therefore, when promoting student activity and engagement, it should be possible for:

- students to engage with the learning content in a variety of ways that may be individual or group-based

- students to utilise learning resources including the available technologies

- students to capture content presented by the teacher and/or the product of interactions with other students

- student groups to equitably access educational technologies

3.5 ESSENTIAL ELEMENT 5: Effective Teaching and Learning is Contextualised and Relevant; Teachers Have an Awareness of Student Prior Learning

3.5.1 Context

Prosser and Trigwell assert that "good learning and teaching are contextually dependent" (1999, p. 168). They argue that the motivation for student learning is sustained by the context and relevance of the subject matter presented by the teacher. However, it is incumbent on the teacher to generate an understanding of prior learning experiences existent in the student cohort to adapt the learning encounter accordingly. According to Prosser and Trigwell:

"What works in one learning and teaching context may or may not work in another context. What works in one discipline or field of study may or may not work in another. What works with the learning and teaching of subject matter 'A' may or may not work with subject matter 'B'. What works with one cohort of students may or may not work with another cohort" (1999, p. 168).

In this sense, teaching requires a continual evaluation of the cohort, leading to potential adaptation of subject matter to increase relevance, fill gaps in core concepts or rectify misunderstandings. Kolb demonstrates this point by describing learning as:

"a continuous process grounded in experience … It implies that all learning is relearning … One's job as an educator is not only to implant new ideas but also to dispose of or modify old ones” (1984, p. 28).

Of course this is more difficult when the student cohort has collectively experienced a wide spectrum of prior learning. However effective teaching also presents the opportunity for negotiated learning and individualisation so that students can work at a pace suited to their context: ‘The effective teacher builds on exploration of what students already know and believe, in the sense they have made of their previous concrete experiences’ (Kolb & Kolb, 2005, p. 207).

Laurillard contends that the teacher must contextualise content and increase relevance by “situating knowledge in real-world activity” that is eminently understandable to the student (Laurillard, 2002, p. 24). Further, she asserts that “academic learning must be situated in the domain of the objective, and learning activities must match that domain” (Laurillard, 2002, p. 24). In this context Laurillard draws parallels with Biggs’s theory of constructive alignment, whereby learning activities relate to learning objectives, which in turn correlate to assessment methods (Biggs, 1996, 2003).

Ramsden simply suggests that making content interesting and enjoyable increases student motivation to learn, but that context and relevance heightens this likelihood. Ramsden declares that teaching and learning is effective “if an explanation of why the particular method or fact that has to be learned will be useful in the future” (Ramsden, 2003, p. 93).

In a review of effective teaching and learning, Skinner draws upon the work of James and Pollard who synthesised ten principles of effective teaching and learning. Among these is that effective teaching and learning “engages with valued forms of knowledge” and “recognises the importance of prior learning and experience” (James & Pollard, in Skinner, 2010, p. 22). Therefore, context, relevance and student prior learning are important aspects of effective teaching and learning that not only make the content interesting but make it enjoyable for teachers to teach and for students to learn.

3.5.2 Teaching and Learning Practice

There are many ways in which a teacher may get to know a cohort of students to gain an awareness of their prior learning, for example, facilitating a whole-of-class discussion, seeking responses to a survey or quiz, or direct conversation with small groups or individual students. Depending on the responses, this may prompt the teacher to adapt their learning plan to either refresh critical concepts to ensure the cohort has the required foundation knowledge or leap ahead to more complex concepts. This may involve accessing web-based content to share with the cohort, running a quiz in class with real time responses or initiating discussion groups. Gaining awareness of prior learning means the teacher is operating in an agile state in order to support an effective learning process.

Students are more likely to take an interest in, and engage deeply with learning content, when they understand its relevance and context. Abstract concepts may be better understood when contextualised by its real-world application. For example, the concept of professional indemnity may appear dry until you understand that you could be sued for providing incorrect advice to a client, resulting in loss of reputation. This could be reinforced by role-playing a scenario in which the roles of various stakeholders are portrayed. Similarly, the classroom could be rearranged to set up a mock court room or subdivided into small 'consulting' suites for psychology scenarios. Or multimedia may be used to bring key concepts to life. Virtual reality (VR) is increasingly being used in classrooms, whereby students can use VR goggles to place themselves in virtual environments to simulate a realistic context. A student may learn about the build up of fatty acids in arteries by experiencing a virtual artery from the perspective of a blood cell. These contextual and realistic learning experiences, linking theory to practice, increase the likelihood of students enjoying the learning process as well as gaining understanding.

Within the context of facilitating relevant and contextual learning experiences an effective teacher will forecast and plan for appropriate resources to be available to the students. This may be in the form of online content, guest speakers, artefacts or VR goggles, to name a few. It may involve the teacher rearranging the room in preparation for a simulation event, such as a mock court room. Students may also bring their own resources to the classroom, in preparation for a specific learning experience. Where regular simulations occur, there may be a storage cupboard to store props or equipment that can be accessed by students.

3.5.3 Summary

Therefore, when teachers make learning contextual and relevant and have an awareness of student prior learning, it should be possible for:

- the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences

- students to undertake learning activities that are relevant to them and their learning context

- students access resources relevant to their needs

3.6 ESSENTIAL ELEMENT 6: Effective Teaching and Learning Involves the Teacher Providing Effective and Timely Feedback to Students

3.6.1 Context

Feedback and evaluation by teachers to their students is a critical element in the discourse on effective teaching and learning. Feedback is often a response to set tasks, or a progressive response to the performance and level of understanding exhibited by the student, but does not necessarily equate to 'assessment'. It aids in the consolidation of meaning and understanding of the subject matter and scaffolds their learning to the next level of complexity.

Hounsell reports on Eizenberg's Interventions in Curriculum, Teaching and Assessment, which articulates that "providing adequate feedback" is critical to "monitoring progress and minimising anxiety" (Eizenberg, in Hounsell, 1997, p. 251). Providing feedback to students is crucial to their developing sense of understanding the content, serving to increase the student's confidence in advancing their cognitive understanding to a more complex level. Evaluation and feedback by the teacher may be exhibited in many different ways, but is primarily either written or verbal. How a teacher evaluates student progress is activated through visual engagement with the student's work (individually or collectively), or in response to an oral presentation or performance.

Laurillard contributes significantly to the effective teaching and learning discourse by presenting what she describes as 'the conversational framework', an iterative dialogue that is "discursive, adaptive, interactive and reflective" (2002, p86). Feedback and reflection are fundamental to the iterative process, enabling students to receive feedback relative to the learning objectives and promoting reflective processes that are "internal to both teacher and student" (Laurillard, 2002). Laurillard draws parallels with Kolb's 'experiential learning cycle', also recognised as an iterative process of 'experience', 'reflective observation', 'abstract conceptualisation' and 'active experimentation' (Kolb, 1984).

Ramsden (2003) highlights the importance of 'appropriate assessment and feedback' as qualitative processes that provide opportunities for students to demonstrate their depth of understanding to the teacher. He contends that:

> *"Setting appropriate assessment tasks implies questioning in a way that demands evidence of understanding, the use of variety of techniques for discovering what students have learned, and*

an avoidance of any assessments that require students to rote-learn or merely to reproduce detail" (Ramsden, 2003, p. 96).

Ramsden indicates the widely accepted position that the method of assessment relates to the approach to learning adopted by the student; that is, rote-learning and reproductive responses increase the likelihood of students adopting a surface approach to learning, whereas continual assessment and feedback increase the likelihood of students adopting a deep approach to learning (Chickering & Gamson, 1987; Ramsden, 2003; Thomas & Bain, 1984).

Biggs and Tang (2007) clarify the importance of formative assessment (feedback that occurs during learning) as opposed to summative assessment (which occurs after learning). They contend that effective learning occurs when students receive continual feedback that is relevant to the learning context, described by Biggs and Tang as 'intended learning objectives' (ILOs):

> *"Effective feedback requires that students have a baseline knowledge of where they are and knowledge of where they are supposed to be heading—what the ILOs are, in fact—and the feedback is meant to slot into that gap in their self-knowledge. Feedback can be provided by the teacher, by other students and by the students themselves, each such source giving a different aspect to the feedback"* (Biggs & Tang, 2007, p. 97).

As Biggs and Tang (2007) remind us, teachers are not the only people equipped to provide feedback to students in the classroom. The prior learning experience that each student brings to the learning encounter, and their own learning perspective, makes feedback between students a powerful mechanism for developing ideas and understanding learning. This possibility reinforces the need to enable equal interaction among small groups of students, in sociopetal settings that embody collaborating, conversing or co-existing (Lawson, 2001).

3.6.2 Teaching and Learning Practice

There are at least two types of evaluation and feedback that should be possible in the classroom environment to support effective teaching and learning: 1) feedback as a result of presentation in class; and 2) feedback as a result of passive monitoring of student work in progress.

Feedback related to presentation in class involves a student or group of students presenting to the whole class, potentially making use of educational technologies. This implies the need for a central location at which the student or group can present from and for the whole class to be able to see and hear the presentation. Feedback related to monitoring of student work incorporates the ability of the teacher to scan the room to evaluate the progress of student work without necessarily interrupting them. Monitoring may be enabled by viewing the learning traces of student interactions that may be present on walls, screens or computers or by reading body language. Scanning the room and viewing learning traces enables the teacher to identify (and prioritise) students who may need assistance, which can be provided immediately.

In any case the teacher requires a vantage point whereby they can stand back from the situated activity to evaluate the status of work prior to any direct consultation. It is also necessary for the teacher to move around the room, to access every student in a way that fosters individual or small group discussion.

3.6.3 Summary

Therefore, when providing effective and timely feedback, it should be possible for:

- the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance

- the teachers to meet individually and/or privately with students to provide direct feedback

- student groups to display the product of their interactions and discussions for the teacher and other students to see

- students to present their work to the teacher and the entire class for feedback

3.7 SUMMARY OF EFFECTIVE TEACHING AND LEARNING ELEMENTS AND BEHAVIOUR

By dissecting the literature relating to 'effective teaching and learning', as a subset of student-centred learning, six essential elements have emerged. Each element has been interrogated in the context of the classroom experience, revealing a range of desirable teaching and learning behaviours to be made possible within NGLEs. This schema, named the Effective Teaching and Learning Behavioural Framework (see Table 4), presents a critical conjunction of effective teaching and learning theory with the environmental psychology literature.

Through the causal relationship between relevant teaching and learning behaviours and the physical learning environment it is possible to mount an argument that the practice of effective teaching and learning can be more adequately implemented in NGLEs, designed to enable the relational effective teaching and learning behaviours. The next chapter will detail the theoretical justification and methods of evaluating the four case studies in this study, including ethics approval and articulation of the research question.

Table 4

Effective Teaching and Learning Behavioural Framework

Effective teaching and learning...		Effective Teaching & Learning should make it possible for:
1.	**encourages the teacher to understand the student's perspective and build meaningful relationships with students**	- the teacher to move around the room and access all student equally and equitably - the teacher to engage with students individually, in small groups or as a whole cohort - the teacher and students to access the same educational technologies
2.	**is a social process whereby knowledge is socially constructed**	- students to hear and watch the teacher and other students - students to interact at a 'personal' or 'social' distance as tasks are being established - students to move around or rearrange the setting to initiate full engagement of tasks at a 'personal' or 'intimate' distance - different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.
3.	**fosters a deep approach to learning that encourages student independence**	- students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions - students to work at their own pace - different students to engage in different activities at the same time
4.	**promotes student activity and engagement with content**	- students to engage with the learning content in a variety of ways that may be individual or group-based - students to utilise learning resources including the available technologies - students to capture content presented by the teacher and/or the product of interactions with other students. - student groups to equitably access educational technologies
5.	**is contextualised & relevant; teachers have an awareness of student prior learning**	- the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences - students to undertake learning activities that are relevant to them and their learning context - students to access appropriate and relevant resources
6.	**involves the teacher providing effective and timely feedback to students**	- the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance - the teachers to meet individually and/or privately with students to provide direct feedback - student groups to display the product of their interactions and discussions for the teacher and other students to see - students to present their work to the teacher and the entire class for feedback

Chapter 4: Methodology

4.0 INTRODUCTION

The previous chapter presented the foundations of the Essential Elements of Effective Teaching and Learning (refer Table 1) and the reciprocal teaching and learning behaviours by examining the convergent literary tracts of the 'effective teaching and learning' and 'environmental psychology' (refer Table 4). This culminated in a summary of effective teaching and learning behaviours expected to be made possible within new generation learning environments. This chapter will detail the methodological context of the case studies presented in this study and articulate the research question.

The field of environmental psychology exists within a social sciences paradigm of qualitative empirical research, often demanding an anthropological approach to data collection. Therefore, the methodologies inherent in the social sciences, in particular methods and approaches to studying environmental psychology, have critically influenced the methodological approach of this research project.

As NGLEs have emerged on campus, universities have naturally demanded evidence to demonstrate that NGLEs are not only worth the significant investment, but that student learning outcomes improve as a result of learning in them. In this sense, evaluation of NGLEs has become a critical concern for universities. This study represents a form of evaluation of NGLEs, but one of the key tasks of the methodological planning has been to establish 'what realistically can be studied?' and 'what types of conclusions can realistically be achieved?'

While the research methodology literature recognises the value of qualitative outcomes, pursuing evidence of higher academic achievement in NGLEs presents an ambitious proposition for universities. However, the author believes that measuring academic results as a success factor for NGLEs is fraught with problems that make this an impossible objective to achieve.

The scenario of comparing one class in a NGLE with another class in a traditional classroom requires the 'conditions' to remain constant in every other way: the same teacher, content, time of day, pedagogical approach, assessment methods and so on. It is impossible to orchestrate two cohorts of students, each with varying conceptions of learning, prior learning experiences and motivations to learn, in addition to varying physiological and psychological dispositions. The variables are simply too many to be able to isolate the physical environment as a determinant of academic success.

Academics at MIT claim that the TEAL Laboratory, presented as an early example of a NGLE in Chapter 2, improves student academic outcomes (Dori & Belcher, 2005). However, this thesis argues that improvements in academic results could be attributed to the adapted pedagogical approach afforded by the physical environment, rather than to the environment itself. The reality of the TEAL Laboratory findings is that the comparison of students learning in two different environments was also a comparison of two distinctly different pedagogical methods. One student cohort experienced a teacher-centred series of lectures conducted in a lecture theatre, while the other experienced a student-centred implementation of PBL in the TEAL Laboratory.

This research asserts that the tremendous success of the TEAL Laboratory has been the degree to which the environment has enabled problem based learning to take place, including enabling the teacher to plan activities to assist students achieve learning objectives, and enabling students to undertake activities to achieve learning objectives. Therefore, it is the author's contention that academic results are not an appropriate measure of a physical environment.

Drawing on the 'environmental psychology' discourse, the physical learning space comprises features that either enable or inhibit the range of teaching and learning behaviours that are possible. Therefore it is considered critical to determine the range of teaching and learning behaviours intended by the teacher to evaluate how the environment supports these behaviours. By drawing connections between the discourses of 'environmental psychology' and 'pedagogy' a methodological approach emerged. More specifically, a study of teaching and learning behaviour was conceptualised within a theoretical framework of 'effective teaching and learning', leading to the core question: **How have new generation learning environments in higher education been conceptualised pedagogically, and designed physically, to enable effective teaching and learning?**

The resultant methodology described in this chapter is, therefore, a qualitative study embedded in the methodological traditions of environmental psychology and incorporating a theoretical framework of 'effective teaching and learning'. Four examples of NGLEs, as defined by this study, were selected for evaluation. Each NGLE is presented as a unique case study with a focus on the "process of inquiry about the case and the product of that inquiry" (Stake, 2000, p. 436).

Two critical components of the qualitative research approach emerge within the case study schema:

1. the method of collecting and recording data
2. the method of analysing data.

Therefore, this chapter serves to describe:

- how the case studies were selected
- why and how the methods of data collection were selected
- how the data were collected
- how the data were analysed.

The methodological proposition generated and tested in this study represents a method of post occupancy evaluation (POE) that serves to establish the spatial and educational affordances of the learning environment. In other words, the evaluation process determines the educational possibilities and limitations commensurate with the physical features of the space and the degree to which effective teaching and learning may be practised in the environment.

4.1 THEORETICAL JUSTIFICATION FOR THE METHODS

This section outlines and justifies the methodological approach of the case studies evaluated in the present study, including the methods of data collection employed within a strictly governed ethical framework. The methodology was planned for implementation within four NGLEs located at four Australian universities:

1) DILE: Deakin University, Burwood campus
2) CTLC: University of Queensland, St. Lucia campus
3) Learning Lab: University of Melbourne, Parkville campus
4) Electrical engineering (EE) PBL precinct: Victoria University, Footscray campus.

The selected case studies represent a diverse selection of NGLE examples, including singular spaces (the DILE and the Learning Lab) and multi-space precincts (the CTLC and the EE PBL precinct). The methodology proposed for the case studies involved interviewing key stakeholders in the design and procurement process, interviewing teachers who use the NGLE and observing the interviewed teachers and their students during timetabled classes in each NGLE. The DILE at Deakin University was selected as a pilot case study to test the methodology, prior to evaluations being implemented in the remaining case studies.

4.1.1 Ethics

A rigorous ethical framework governed the evaluation process, which in the context of this study involved protecting the rights of people being interviewed. An extensive explanation of the data collection methods was provided in the ethics application, for consideration by committee. The primary activity of concern to ethics committees revolved around a series of interviews proposed to take place with stakeholders responsible for design and procurement, and teachers who teach in the NGLE. This included describing how participants would be selected and invited to participate, the nature of the questions and topic to be discussed during interviews and how the research project would be explained to participants and their consent obtained.

Key concerns in implementing an ethical research process included:

- ensuring participants were ‘invited’ to participate without coercion
- participants being provided with an explanation of the research project
- participants consenting to participate (in writing)
- personal details of participants (such as names and email addresses) being handled in an appropriate manner, in accordance with State and Commonwealth privacy legislation
- participants being informed they could withdraw from the research project at any time without consequence
- systems being put in place to address complaints or stress experienced by participants.

The ethics application was approved by the Monash University Standing Committee on Ethics in Research Involving Humans (CF07/3928- 2006/922). Deakin University, the University of Queensland and the University of Melbourne each confirmed that the Monash University approval satisfied their institutional ethics processes and required no further application process. A separate ethics application was approved by the Victoria University Human Research Ethics Committee (HRETH 07/248).

4.1.2 Case Study Methods

Case study approaches demand the validation of data through multiple methods of collection, with a view to revealing convergent conclusions from the analyses. The literature reveals a tension between the need to report accurately and the desire to draw conclusions and generalisations from data that can be repeatedly collected with consistent results (Stake, 2000). As this study is presented as a qualitative study, identical results between repeat methods are improbable; however multiple sets of data validate general, yet critical conclusions.

POE is an example of a case study approach but is a broad term with varied meanings. The term is sometimes used to describe the process of measuring building systems, such as the performance of air conditioning and emergency systems (Federal Facilities Council, 2001; Preiser, 1989). The term can also describe the measurement of environmental conditions such as energy efficiency, acoustic performance and air quality (Preiser & Vischer, 2005), a process frequently undertaken in hospital buildings (Loftness, Choi, Gu, Hua & Snyder, 2006). In the context of the present study POE has been developed by the author as a method of identifying qualitative educational outcomes of NGLEs, drawing influence from POE studies undertaken in the field of environmental psychology (Bechtel, 1997; Sanoff, Christie, Tester & Vaupel, 2006; Zimring & Reizenstein, 1980).

Researchers in the field of environmental psychology define POE in terms that are more aligned with this study. Zimring and Reizenstein refer to POE as 'an examination of the effectiveness for human users of occupied design environments' (1980). Bechtel contends that POE 'evaluates both the design and the human needs in relation to each other' (1997). Lackney not only describes POE as 'the process of systematically evaluating the degree to which occupied buildings meet user needs and organisational goals' (Lackney, 2001); he also presents an educational context for POE describing school spaces in terms of their 'educational adequacy' (Lackney, 2001, 2005).

A conference hosted by TEFMA (Fisher, 2005) and attended by the author presented a number of new types of learning spaces that were newly completed, in construction or in planning across numerous Australian universities. As the conference was hosted by the University of Queensland, it presented the opportunity to visit the newly completed CTLC at the University of Queensland, which was immediately identified by the author as a potential case study. The DILE at Deakin University and the EE PBL precinct at

Victoria University in Melbourne, Victoria were subsequently visited by the author.

Other examples of new learning spaces were identified. However these three learning spaces appeared to best exemplify the author's definition of a NGLE; that is, a single space or suite of settings designed to improve teaching and learning through the provision of physical environments that enable effective teaching and learning processes. The 'learning environment designer' (LED) involved with the CTLC at the University of Queensland subsequently relocated to the University of Melbourne, precipitating the design of the Learning Lab. The uniqueness of the Learning Lab created immediate interest and was rendered the fourth case study in this research project.

Each of the four case studies was investigated to explore the degree to which teachers were capitalising on the educational capacity of each learning environment, with an intrinsic interest (Stake, 2000) in how each NGLE was used by both teachers and students. Each case study was selected on the basis of their similarities in enabling effective teaching and learning to take place. However, all case studies differed in terms of their size, setting, intended behaviour, technology capacity and educational context. Each case is reported independently of the others, in terms of:

1) How was pedagogy considered in the design and procurement process? That is, what did the architect and facility manager expect would take place educationally in the NGLE?

2) What teaching and learning activities (TLAs) did the teacher anticipate would happen during a specific timetabled episode?

3) What TLAs occurred during the observed timetabled episode?

The case study method requires a strategy for collecting and recording data, focusing the line of inquiry and a process of analysis that continues to evolve through to the final reporting of the case. The narrative of the report enables the researcher to interpret the data through the prism of their research objectives (Stake, 2000), in this case, **How have new generation learning environments in higher education been conceptualised pedagogically, and designed physically, to enable effective teaching and learning?** "The case researcher emerges from one social experience, the observation, to choreograph another, the report" and in this sense "researchers assist readers in the construction of knowledge" (Stake, 2000, p. 442).

Analyses and conclusions are more likely to be validated where multiple methods of data collection are employed. Triangulation is "considered a process of using multiple perceptions to clarify meaning", although it is not expected that “observations or interpretations are perfectly repeatable” (Stake, 2000, p. 443). This is supported in specific literature on POE where a consensus exists that an effective evaluation will incorporate multiple data collection techniques. Friedman, Zimring & Zube (as cited in Zimring and Reizenstein) report that multiple methods of data collection are essential in establishing “convergent validity—that is, a variety of methods are used so that strengths of some methods compensate for weaknesses of others—and that a range of methods is necessary in POE to capture various aspects of a social-physical system” (Friedmann in Zimring & Reizenstein, 1980, p. 441). Similarly, Ziesel states that “in case studies, multiple research techniques, especially participant observation, are often needed for investigators to get sufficient data about different aspects of an object” (Ziesel, 2006, p. 98).

Architect Henry Sanoff (2006) describes four techniques: observation and behavioural mapping; activity logs; social mapping; and surveys with semantic rating scales. They utilise observations to increase understanding of the activities that take place in a given setting, and behavioural mapping to record the observations. Mapping may be recorded using a data form with quantitative or qualitative criteria, or consist of an actual plan or map of the environment whereby movement and time are tracked throughout a space. Social mapping was utilised by Sanoff to seek responses from user participants who expressed “preferences and rejections in terms of how they perceive themselves in relation to other members of a group” (2006, p. 157).

Environmental design researcher Min Kantrowitz and academic Richard Nordhaus (1980) describe a case study utilising five techniques: surveys; semi-structured interviews; behavioural mapping; walk-through observations; and site condition surveys. Their research sought to evaluate subsidised housing with the objective of informing public housing policy in Albuquerque, New Mexico. Resident surveys and site condition surveys were used to collect quantitative data; interviews, behavioural mapping and walk-through observations were used to record qualitative data. The combination of data methods led to a range of issues being identified and validated, with significant implications for policy makers, architectural consultants and ultimately, the residents.

Therefore, building upon this literature, triangulation and reporting of each case study in this research project is intended through the following multiple methods of data collection:

1. Semi-structured interviews with:
    a. people involved with design and procurement of the NGLE
    b. teachers who practice undergraduate teaching in the NGLE relevant to the teaching episode to be observed.
2. Observational studies of formal teaching episodes, incorporating:
    a. activity mapping of students
    b. activity and movement mapping of teachers.

The limitations of the ethics framework required that participants could not be approached directly by the author, to avoid any perception of coercion. In the first instance, the directors of facility services (with differing but equivalent titles) at the institutions were approached with an explanation of the study and a request for them to identify and 'invite' the facility manager, project manager and architect to participate. A facility manager is traditionally the person responsible for the procurement process including commissioning the architect and appointing an internal project manager. Therefore, the facility manager is considered one of the key stakeholders in the entire process. The facility manager, where possible, was also asked to suggest other key personnel who were involved with the design process. This is why, for example, a timetable manager was interviewed for the DILE and not for any other case studies. The timetable manager was considered by the Deakin University facility manager to have a unique perspective of the DILE that was worth investigating.

Upon their consent, direct contact was established, particularly with the facility manager who then identified the relevant faculty contacts to initiate teacher participation. A similar process ensued with a number of faculty managers who identified teachers who actively teach undergraduate students in the respective NGLE. Teachers of undergraduate students were the focus because undergraduate learning is essentially a teacher-driven process whereby it is the teacher's approach that determines what students do in the classroom. The faculty managers invited several teachers, instructing them to contact the author directly with their consent.

The author was reliant upon this process for determination of the final participants. For example, it was disappointing that neither the facility manager for the PBL precinct at Victoria University nor more teachers availed themselves to participate; however the ethics process prevented the author from encouragement through direct contact. The Victoria University case study was still considered a crucial NGLE to be evaluated, albeit with a limited number of participants, as it represents a distinctly different series of settings compared with the other case studies. The final list of participants for the collection of case studies is shown in Table 5.

Every effort has been made by the author to conceal the identity of participants in all case studies. In some instances, this was problematic because there may, for example, be only one facility manager, who a discerning person could potentially identify. The low-risk nature of the interviews and subject matter diminished concerns for the people in this situation. However, it was considered critical to protect the identity of teachers to ensure that, if compelled to be critical of institutional processes or design outcomes, they would suffer no consequences for doing so. As such, they have been accorded codes, T1, T2, T3 and so on. The same code has been used for each case study: that is, there is a T1 in each case study. The qualitative data collection methods, interviews and observational studies will now be described in greater detail.

Table 5.

List of Case Study Participants

CASE STUDY C1 Deakin Immersive Learning Environment (DILE) Deakin University	CASE STUDY C2 Collaborative Learning & Teaching Centre (CTLC) University of Queensland	CASE STUDY C3 Learning Lab University of Melbourne	CASE STUDY C4 Electrical Engineering PBL Precinct Victoria University
– Facility Manager – Architect – Timetable Manager – Technology Manager – 3 No. teachers	– Learning environment designer – Project Manager – Architect – Technology Manager – 5 No. teachers	– Learning environment designer – Facility Manager – Project Manager – Architect – Technology Manager – 4 No. teachers	– Architect – Laboratory Manager – 2 No. teachers

4.2 DATA COLLECTION METHODS

4.2.1 Interviews

A semi-structured interview presents the opportunity for the researcher and participant to engage in a conversation on an agreed topic of interest (Fontana & Frey, 2000; Kvale, 1996). The semi-structured format enables the researcher to adhere to the 'conversation' topic, while maintaining an informal and relaxed manner. The key competence in conducting an interview is for the researcher to actively listen and respond to each participant's answers, while drawing out responses that relate to the specific topic under investigation:

> *"The research interview is an interpersonal situation, a conversation between two partners about a theme of interest. It is a specific form of human interaction in which knowledge evolves through a dialogue"* (Kvale, 1996, p. 125).

In this study the author deliberately submitted a naive persona that encouraged the participant to explain their responses in great depth and detail. This demonstrated what Kvale refers to as an 'asymmetry of power', contending that the research interview is "not the reciprocal interaction of two equal partners" (Kvale, 1996, p. 126).

The topic of conversation with key people involved in the design and procurement of the NGLEs centred on their understanding of what type of teaching and learning was to take place and whether or not a specific pedagogical concept influenced the design process. The author sought to establish if and how stakeholders of the procurement team distinguished the NGLEs they were designing from other, more conventional learning spaces. This line of inquiry served to track the design and procurement process including extraneous influences such as timetabling and technology management.

Interviews with teachers occurred prior to the observational study. Conversations centred on their conception of teaching and learning as well as their understanding of how the physical classroom environment was considered in planning the teaching and learning episode. Understanding the teacher's disposition to teaching and learning prior to the observation was critical to the methodology. That is, did they conceive of their teaching as being explicitly student centred or teacher centred, or somewhere in between? It was anticipated that this would serve to explain the teaching practice to be observed during the timetabled episode. For example, if a teacher was observed practising in a teacher-centred manner it was important to know this was their teaching disposition, rather than a result of the limitations of the physical environment. The interviews were audibly recorded and transcribed into text for hermeneutical analysis, a process where the "concepts of conversation and text are pivotal, and there is an emphasis on the interpreter's foreknowledge of a text's subject matter" (Kvale, 1996, p. 38). The author interpreted the transcripts, drawing upon theoretical constructs of teaching and learning, which were overlaid with data collected during the observational studies.

4.2.2 Observational Studies

Observational studies can be conducted in many ways, from discrete locations where participants are unaware they are being observed, to being a participant observer where the observer is 'disguised' as one of a group of participants. In the context of observing teachers and students in NGLEs, the case study environments did not afford the opportunity for covert observation. It was also unrealistic for the author to 'pretend' to be a student for the purpose of the observation, as the community of students was generally well established. Therefore, the author proposed to become a passive observer, or what Ziesel calls a 'recognised outsider', with full disclosure to the students of the researcher's purpose for being present:

> *"In complex situations observers of behaviour get a sense of chain reactions: the effects of effects. No other method gives a researcher such a rich idea of how people bring places to life"* (Ziesel, 2006, p. 195).

Passive observation naturally leads to concerns regarding what is known as the 'Hawthorne effect', where the participant's behaviour changes as a result of the presence of the researcher (Adair, 1984). However, there are three reasons why the author was confident the Hawthorne effect would not influence the outcomes of this study:

1) the low-risk nature of the research project, as explained to the participants
2) students were generally following the instructions of the teacher, with varying degrees of autonomy
3) teachers had expressed during the interview clear plans for the class to be observed, which decreased the likelihood of the teacher being distracted by the passive observer.

The author also took care to undertake the observations from a static location in each NGLE that would not reinforce to students they were being watched.

Observational studies draw from a foundation of ‘interpretivism’ whereby the researcher seeks to gain understanding through “the act of looking over the shoulders of actors and trying to figure out (both by observing and conversing) what the actors think they are up to” (Geertz, as cited in Denzin & Lincoln, 2000, p. 192). In this sense the author anticipated being able to hear some conversations between students and teacher and among students, but did not intend to engage in conversation in the classroom, to avoid distracting students from their primary tasks. Some degree of interpretation was required, but the intention was for the author to detect whether or not students were engaging in the learning activities initiated by the teacher.

It was not intended for the author to seek understanding of the students’ state of mind or health, but simply to ascertain if students appeared to understand what they were required to do and to observe whether or not the classroom enabled those activities to take place. The evaluations were conducted in NGLEs that were established as ‘natural settings’, where teachers and students participated in ordinary, scheduled TLAs (Zeisel, 2006). That is, the teaching and learning episodes were not contrived for the benefit of the research project.

While there are aspects of this study that are phenomenological, the study cannot claim to be immersed in phenomenology. The author was present in the classroom with the teacher and students, experiencing the same physical conditions; however, the author’s purpose for being present was a significant point of differentiation. The author was not an undergraduate student undertaking the class; the author did not seek to understand the individual contexts for each student’s learning experience, such as the workload of other subjects or stability of life outside of university. The author was not privy to the teacher’s pressure to impart, engage and facilitate the student learning experience, nor their external pressures relating to research and administration. If phenomenology is “concerned with understanding how the everyday, intersubjective world is constituted” (Schultz, as cited in Denzin & Lincoln, 2000, p. 192), then in the context of this study the phenomenological aspects are limited to the author’s experience of being in the same physical environment as the teacher and students.

The observational studies within the NGLEs focused on two fundamental aspects: 1) the physical features of the room/precinct; and 2) teaching and learning behaviour in relation to the physical features of the NGLE. It was expected that the teacher, in each instance, would conduct their teaching episode in the manner described in the preceding interview. Considering the NGLE has been designed for student-centred learning, it was expected that students would be observed engaging in collaborative and interactive activities.

A key attribute of undergraduate student-centred learning is that it is essentially teacher led, a distinctly different concept to teacher-centred learning. Teacher-led learning involves the teacher having a deliberate plan of what students are to learn, but how students engage with the content and achieve the learning objectives is planned by the teacher to involve student activities. In this sense, it was expected that some teacher-led instruction would exist, but not dominate the learning episode. The author expected to observe teacher-led instruction interspersed with student activity, but that the majority of the timetabled event would involve observing student activity.

It was not expected that teachers would stand and deliver a lecture during the learning episode. Although teachers and students were being observed in their natural environment—that is, the NGLE—it is important to clarify that the quality of teaching and learning was not being evaluated or judged. The focus remained acutely on a) whether or not the teacher was able to enact the teaching plan described during the interview; and b) how the physical features of the environment enabled or inhibited the activities that teachers and students were undertaking.

The method of recording the observations was anticipated to involve using a plan of each space to ethnographically document where students were located in the NGLE, differentiating between male and female students. Features of the room were intended to be recorded; for example, location of doors, windows, steps, furniture types and layouts, finishes and visible technology. The movement pattern of the teacher was intended to be mapped onto the plan, as was student movement when it occurred. The author also intended to record the activities of both teachers and students, including the duration of each activity. However, the full implication of activity duration did not emerge until the trial evaluation had been completed.

4.2.3 Summary

While POEs conducted in the field of environmental psychology provide a useful guide to the nature of evaluating NGLEs using multiple methods of data collection, the author did not establish a comparative evaluation in a higher education context. Sanoff and Lackney published methodologies associated with school environments (Lackney, 2001; Sanoff et al., 2006). Bechtel (1997) and Zimmerman and Martin (2001) published methodologies in the context of other types of environments. Sommer and Olsen (1980) and Horowitz and Otto (1973) conducted independent behavioural studies of students in university classrooms designed to increase interaction but neither study sought to establish the teacher's conception of teaching and learning.

The lack of POE projects and publications relevant to learning environments in higher education at the time the methodology for this study was being conceptualised resulted in the determination by the author to test the methodology on one of the case studies, rather than commit to implementing an untested process for all case studies. The DILE at Deakin University presented as the ideal pilot case study. As a single NGLE, the methodology was uncomplicated by multiple spaces. Further, it had been in operation for approximately one year, meaning that any space management issues capable of contaminating the data would likely have been resolved.

4.3 PILOT CASE STUDY

The DILE at Deakin University was selected as the pilot case study with the objective of testing the methodology described in the ethics application. While many aspects of the data collection process had been considered in obtaining ethics approval, it was anticipated that other elements may only become apparent during data collection. If any oversights emerged in the methodology it was anticipated that the ethics approval could be amended prior to implementation of the remaining three case studies.

4.3.1 Test Methodology

The ethics process unfolded to establish a range of participants who consented to being interviewed, along with a number of teachers who additionally consented to having the author observe one of their timetabled episodes. The interviews with the procurement team took place first, although this was not a deliberate schedule of order. The critical order of events was that the teacher interview occurred prior to the relational observation.

The observational studies were undertaken as planned. The observational experience raised one fundamental issue that significantly influenced the remaining case studies. The author was not permitted to photograph students in the DILE within the framework of the approved ethics application. Although images of the DILE had been captured in a previous site visit, the potential value of images demonstrating the types of activities engaged in by students became evident during the observations. Photographs would provide an additional source of data to validate the observation documentation, unequivocally demonstrating key behaviours for discussion.

Taking photos of students as part of any research project requires consent from each participant, an element that had not been included in the initial ethics application. Spatial images without people, or in this case students and teachers, are static, lifeless and do not convey the true sense of purpose of the environment. In this context it was worth seeking an amendment to the ethics application, enabling capture of still images of students and teachers in situ, for the remaining case study spaces. Therefore, an ethics application amendment to collect photographic evidence of students and teachers in each NGLE was made and approved.

4.3.2 Data Analysis

The pilot case study served as an opportunity to test the nature and quality of data collected and to test the efficacy of data in responding to the fundamental research question: **How have new generation learning environments in higher education been conceptualised pedagogically, and designed physically, to enable effective teaching and learning?** Following observations and interviews relating to the DILE, the pool of data included seven transcripts and three sets of observational diagrams. Four of the transcripts related to the design, procurement and space management process. Two transcripts described the teacher's conception of teaching and learning in relation to the subsequent observational study. One transcript represented an academic's involvement in the design process as well as their teaching experience in the DILE. Transcripts were categorised as 'teaching', 'design and procurement' and 'space management'. Each category of transcript was dissected to reveal a number of common themes. These emergent themes were not anticipated when planning the interview questions and topics for discussion, but developed as a result of the conversational method of the interviews. When a topic of importance was conveyed by one interviewee, however, questions relating to that topic were sometimes followed up with other participants. For example, two of the academics discussed the limitations of the technology in the DILE, which led to questions pertaining to those limitations being directed to the technology manager who was interviewed.

The transcript data sets were 'cleansed' to remove sections of conversation that bore no apparent significance to the research project; for example, conversational tangents that developed during the interviews. The remaining text was arranged according to the themes that had emerged, to enable comparison between categories of transcripts; that is, 'teaching', 'design and procurement' and 'space management'. This process created a robust educational narrative that, when overlaid with the observational data, became the foundation of the case study report.

The observational data included a series of sketches for each classroom episode observed. The sketches (in plan) reflected the furniture arrangement, where students were seated, which students were working in groups, where students relocated during the class and where the teacher was located for specific activities. In addition to sketches, the author generated notes to describe what the teacher and students were doing at different times during the class, and the duration of the various activities. The notes were tabulated with a time code to indicate the flow of activities. Sketches of movement and group work were added to the table to indicate how those activities related to the time code. These data sets presented a useful diagrammatic representation of each class that clearly conveyed the nature and duration of the classroom activities.

4.3.3 Outcomes

Testing the methodology on a pilot case study proved to be an invaluable process. Essentially the multiple methods of data collection appeared robust, with data generating a range of useful insights and a clear educational narrative. The data enabled the author to draw conclusions relating to the pedagogical genesis of the design and how teachers used the room's features to implement the planned student-centred learning activities. However, several unanticipated insights emerged that significantly influenced the subsequent case study methods. These included: a) the identification of several external space management issues that were discovered to seriously affect teaching and learning conceptions of the DILE; b) some interview questions were deemed to be less relevant to the primary research question; and c) categories of teaching and learning behaviour were identified, which, when overlaid with the time code in the observational data, provided a measure of the teaching and learning approach taking place in the NGLE.

4.3.4 External Space Management Issues

It was not immediately apparent why the timetable manager had been recommended as a participant in the study. However, the timetable manager described considerable confusion among academics regarding the purpose of the DILE; he admitted his own uncertainty as to the special nature of the space. After several complaints from academics contending that the space did not meet their needs, the timetable manager sought clarification from the primary academic stakeholder who explained how the space had been designed for a specific type of teaching and learning. The timetable manager was then better informed to advise other academics who were timetabled to use the DILE.

This revelation highlighted the range of ‘external issues’ that can affect the use of teaching and learning spaces; that is, elements that are not directly related to the activities of teaching and learning, but have the potential to seriously influence the effectiveness and use of an environment. This insight prompted the author to interrogate external space management concerns with participants in the subsequent case studies, contributing to the author’s unique comprehension of holistic issues surrounding the advent of NGLEs on university campuses.

4.3.5 Categories of Teaching and Learning Behaviour

The time coding of observed activities of teachers and students led to the realisation that activities could be classified into one of five simple but distinct categories:

1) start and end of class
2) teacher directed
3) teacher-led interaction
4) student activity
5) student presentation.

4.3.5.1 Start and end of class.

This activity involves the students arriving at the classroom, finding a seat and settling down ready for the class to commence. Conversely, the end of class involves students packing up their belongings and leaving the classroom. The duration of this activity varies between classes, with some classes taking considerable time to get started; hence the importance of recognising this activity as a distinct category.

4.3.5.2 Teacher directed.

This category describes a didactic presentation or lecture by the teacher, without any attempt to interact with the students. It may include standing and talking, with or without utilising presentation devices. The teacher may move around the room in this category of activity, but does not seek interaction with students. This category exemplifies teacher-centred teaching, as recognised in the educational literature (Ramsden, 2003; Svinicki & McKeachie, 2011).

4.3.5.3 Teacher-led interaction.

This activity describes the process of a teacher leading an iterative discussion, directing questions to specific students or to the general cohort. The teacher responds to the answers provided by students, reflective of Laurillard's 'conversational framework' (Laurillard, 2002) or the Socratic method (Rudebusch, 2009). The teacher may undertake this activity with or without presentation devices. The key element is that the teacher is attempting to guide student understanding of a concept through discussion and interaction.

4.3.5.4 Student activity.

This category refers to all activities where students are engaged in a specific task as instructed by the teacher, but conducted as individuals or collaboratively in a group, in the classroom. The task may be quite specific and may be directed with a time limit. For example, 'in your groups you have 10 minutes to discuss...'. Alternatively the task may be much broader and over a longer period; for example, a project that is negotiated between students and the teacher and is due for completion at the end of semester. This category exemplifies student-centred learning as defined in the educational literature (Brandes & Ginnis, 1986; Gibbs & Habeshaw, 1996; Marlow & Page, 2005).

4.3.5.5 Student presentation.

This category refers to the process of student groups sharing the findings of their student activity (undertaken in the classroom) with the whole class, facilitated by the teacher. It usually occurs at the end of the class, or at the end of a designated period.

4.4 ELECTRICAL ENGINEERING PROBLEM-BASED LEARNING PRECINCT AT VICTORIA UNIVERSITY CASE STUDY

The author was confronted with a methodological dilemma upon commencing evaluation of the EE PBL precinct at Victoria University. The educational structure of the course was distinctly different from the other case studies, but this did not become apparent until interviews with the teachers ensued. In the EE educational model, students are assigned to groups of five or six students, with a supervising teacher to guide the process. The PBL groups are also assigned a designated 'studio' for the entire semester, enabling students to work collaboratively or individually at times convenient to the students. Rather than bringing student groups together into one space where a teacher, or supervisor conducts a classroom-based consultation—and where the prescribed methodological processes could be implemented—each PBL group planned to meet with their supervisor once per week for 1 hour in their assigned studio.

One instance of this was experienced by the author, but it became immediately apparent that the planned methodology was not appropriate for evaluating the EE PBL precinct. The teaching and learning episode amounted to a meeting around a table in the studio environment. There was little physical movement by teacher or students; they simply interacted with each other through discursive conversation and exhibiting examples of work. The teacher's conception of teaching was dramatically different from that of a teacher in a classroom environment. The students were required to complete a semester-long collaborative project; the teacher supervised the process by ensuring that students were making progress and, where necessary, directing students to include specific concepts in their assignment. The teacher's mandate was not to provide the answers but to point students in the direction of understanding key concepts. The relationship between the teacher, the students and the physical environment was entirely different in the EE PBL precinct. The recognition of the unsuitable methodology warranted a significant reconceptualisation of methodology for the Victoria University case study.

Establishing the design, procurement and space management issues through semi-structured interviews as per the original methodology was deemed to be appropriate. Teachers could still be interviewed for their perspective as 'supervisors', but this would not relate to a particular observation. Sitting in on occasional meetings between a supervisor and a PBL team was not going to provide a sense of how students used the whole precinct.

Conceptually, the ideal methodology would have been to follow a selection of volunteer students around for a period, to map which facilities they utilised, for how long and for what kinds of activities. It was, however, unrealistic to literally follow students around in this way. Therefore, the concept of developing a diary for students to complete over 1 day was pursued.

The student diary concept needed primarily to be simple and easy to complete. The diary needed to include a time code to establish the duration of student activities, recognition of the facilities within the precinct that the author was interested in tracking (e.g., toilet facilities were not of interest), prompts asking students to describe the tasks they were doing and if they were undertaking tasks in collaboration with others.

The following questions were proposed to students in the diary format (see Figure 16 for a sample diary template):

- What task were you doing? (Relating specifically to your engineering PBL coursework)
- Where were you located? (Studio cabins, common room, lecture theatre, laboratory, or other) (please specify)
- Why did you locate yourself there? (As opposed to somewhere else?)
- Who was with you? (Fellow group members, supervisor, other students…)
- Who or what else did you interact with? (What resources did you utilise? Computers, lab equipment, other (please specify), supervisor, lab tech?)

This new methodology required an amendment to the Victoria University ethics application, the primary concern being to ensure that students were not coerced into completing the diaries. In this context supervisors were not permitted to invite students to complete the diaries, lest there be any perceived coercion because of the supervisor's 'unequal' relationship with the student. The author was reliant upon a process of distributing the diary template to all EE students via their student pigeon holes and requesting the diaries be returned in a pre-addressed envelope that was attached to the template. The revised methodology was approved by the Victoria University Human Research Ethics Committee and implemented accordingly.

Despite diary templates being sent to over 100 students, only four diaries were returned. While this was disappointing, it was nonetheless considered the equivalent of following four students around for a day. In addition to the student diaries and transcripts of interviews with other key stakeholders, this case study was also informed by a number of papers by academics writing about their experience of introducing PBL to the EE discipline. Many of these papers were peer reviewed and were considered a credible source of data, to validate other data sets collected for this case study.

4.5 CONCLUSION

The four new generation learning environment case studies have been evaluated within a social sciences context, whereby multiple methods of data (such as interviews, observations and activity mapping) have been triangulated to develop insights into the teaching and learning behaviours that are enacted in the NGLEs. These methods were generated in response to the core research question: **how have new generation learning environments been conceptualised pedagogically, and designed physically, to enable effective teaching and learning?**

The methodology was tested using the Deakin Immersive Learning Environment (DILE) as a pilot and adapted slightly for the Learning Lab and Collaborative Learning and Teaching Centre (CTLC). A different method was applied to the Electrical Engineering PBL studios at Victoria University, in response to the different teaching and learning program. The next four chapters will detail each of the four case studies, beginning with the pilot case study of the Deakin Immersive Learning Environment (DILE). Each case study will include commentary from teachers who teach in the DILE, commentary from the architect and other stakeholders involved in its development, as well as observations of formal learning episodes.

PBL ENGINEERING STUDIO, STUDENT DIARY **DATE OF COMPLETION:** **PLEASE COMPLETE BY FRIDAY 26TH SEPTEMBER 2008**

Time	What task were you doing?	Where were you located?	Why did you locate yourself there?	Who was with you?	Who or what else did you interact with?
	Relating specifically to your Engineering PBL coursework.	Studio cabins, common room, lecture theatre, laboratory, or other (please specify)	As opposed to other places you could have gone to study?	Fellow group members, supervisor, other students…	What resources did you utilise? Computers, lab equipment, other (please specify), supervisor, lab tech?
8am					
8:15					
8:30					
8:45					
9am					
9:15					
9:30					
9:45					
10am					
10:15					
10:30					
10:45					
11am					
11:15					
11:30					
11:45					
12noon					
12:15					
12:30					
12:45					
1pm					
1:15					
1:30					
1:45					
2pm					
2:15					
2:30					
2:45					

This project is voluntary. I understand I can withdraw at any time. I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any research publications and presentations.

Upon completion, please return using reply paid envelope

New Generation Learning Environments for Higher Education
Victoria University Ethics Project No. HRETH 07/248

Figure 16: Sample of student diary template for the Victoria University case study, C4.

Chapter 5 - Trial Case Study 1: Deakin Immersive Learning Environment (DILE), Deakin University

5.0 INTRODUCTION

As outlined in Chapter 4, a trial case study was initiated to explore the efficacy of the proposed research methodology and the nature and quality of the data generated. The trial was undertaken in the DILE, a space selected as an example of a NGLE as defined in this study. As a singular space it was deemed an appropriately scaled environment in which to test the methodology.

The DILE represents Deakin's first attempt at creating a classroom specifically for timetabled collaborative learning. It manifested from one academic's personal vision of teaching and learning, with the intention that other academics would have a place where they could develop a more student-centred approach to teaching and learning. This chapter focuses specifically on the internal enablers, the affordances of the space that have contributed to a variety of collaborative teaching and learning experiences.

The participants in the evaluation of the DILE were four academics who taught in the DILE (subsequently identified as T1, T2, T3 & T4), the architect, the facility manager, the audio visual manager (AVM) and the space allocation (timetable) manager. Interviews were conducted with all participants except T4 and three classroom observations were conducted subsequent to interviews with the corresponding academics. The academics were differentiated as follows:

- T1 was the primary academic stakeholder who initiated the new environment, but also coordinated and co-taught

  third year multimedia students with T3
- T2 coordinated a first year multimedia subject
- T3 co-taught third year multimedia students with T1, although T1 was not present during the observation
- T4 tutored for T2 in first year multimedia, but was not interviewed as their role was at the direction of T2.

All observed classes were of 2 hours' duration and were preceded by a 1-hour lecture conducted in a lecture theatre (not observed). The interviews and observations took place during Weeks 3 and 4 of Semester 1 in 2007.

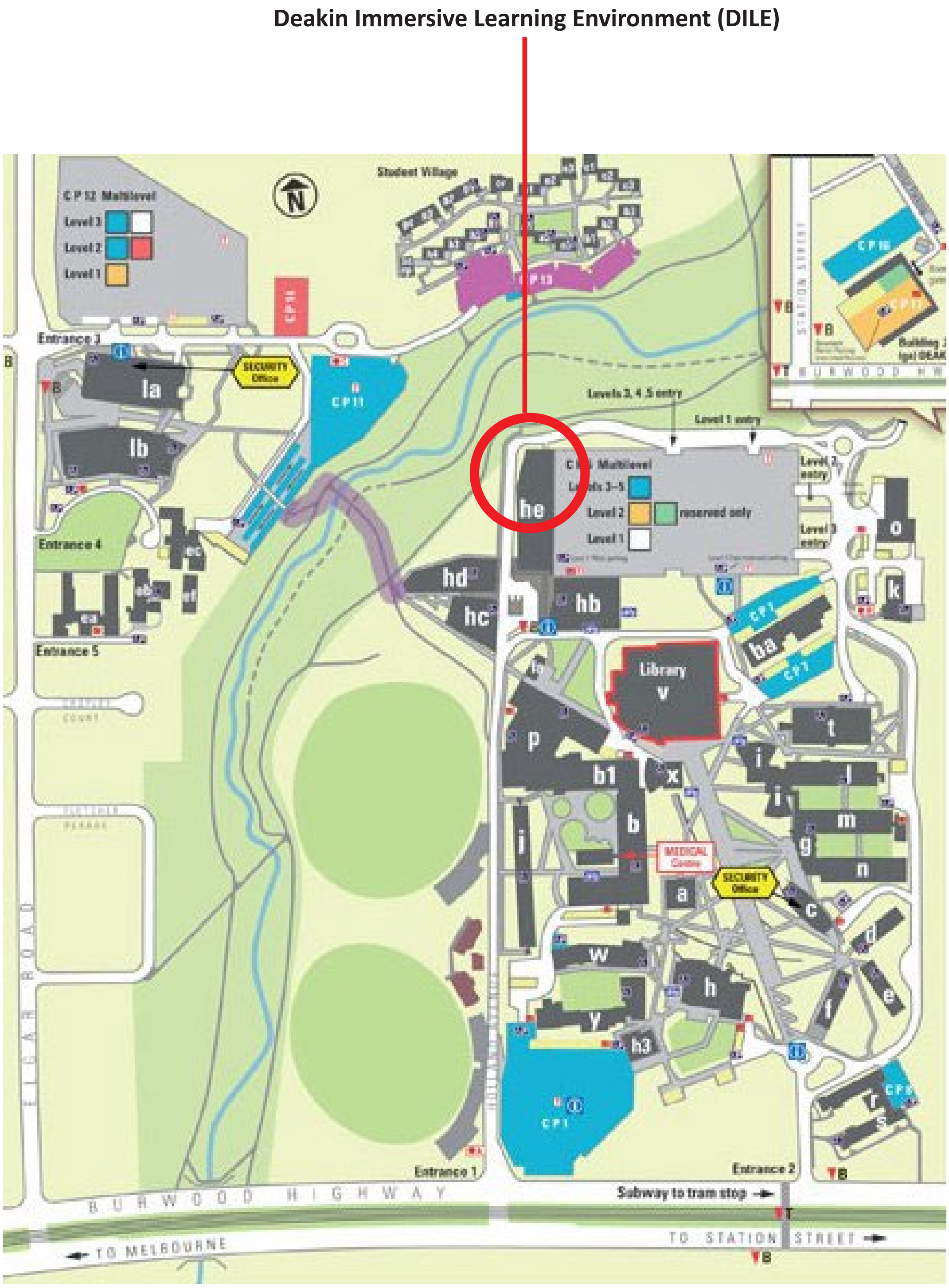


Figure 17: Location of the DILE at Deakin University, Burwood Campus, 2007.

5.1 UNIVERSITY CONTEXT

The DILE is located on the ground floor of the 'he' building in the north-west corner of the Burwood campus (see Figure 17). The DILE was originally conceptualised as an environment that would simulate aspects of a professional multimedia studio, although it was also intended to have diverse teaching and learning applications. It was to provide an environment where students could study interactively and collaboratively, which was not afforded by lecture theatres, general teaching spaces or computer laboratories. The ideas embedded in the DILE were strongly aligned with Deakin's teaching and learning objective to provide excellent teaching, flexible delivery options and professionally focused programs developed in consultation with industry (Giles & Verso, 2005).

The DILE is a single-space, L-shaped classroom, accessed via a walkway along the western side of the building. The building is bordered by a main access road to the north and west, with a multi-level car park to the east. Gardner's Creek and parkland is situated beyond the main road, separating the main campus from the student residences and providing a pleasant visual relief from the otherwise urban sprawl that surrounds the campus.

5.2 ORIGINS OF THE DEAKIN IMMERSIVE LEARNING ENVIRONMENT

T1 had experienced the development of a new multimedia facility at a previous university, incorporating a new studio environment. Upon relocating to Deakin University, T1 found the teaching spaces allocated for her teaching were vastly different from those experienced at her previous university. At Deakin, multimedia was perceived as a computer-intensive program and therefore taught almost entirely in computer laboratories, complemented with a series of supporting lectures. Not only was T1 unable to practice her preferred teaching method, she found that the allocated computer laboratories resulted in her delivering course content that was disconnected from the professional experience of being a multimedia designer. Computer laboratories led to classroom episodes being overtly computer based and inhibited the ability of teachers to plan for, and students to engage in collaborative learning:

"My previous research has always been focused on environment as being pivotal to enhancing the learning experience. I have a number of concepts that comprise a pedagogic method of some sort, the four elements of: [1] immersion, [2] engagement, [3] risk taking and creativity and [4] agency. I believe those four elements are only possible within a particular type of learning space" (T1).

T1 began a conversation with a facility manager about the possibility of creating a new classroom environment that would enable her to teach multimedia in ways that aligned with: i) her theoretical approach to teaching and learning; and ii) the experience of working in a professional multimedia studio. The intention was for multimedia to be taught in a learning space rather than a computer laboratory.

The facility manager was receptive to T1's ideas as he had been engaging in discussions around new approaches to designing learning environments, through his involvement with professional industry bodies such as the SCUP network in the USA. He was concerned that the majority of classrooms at Deakin University were being designed to suit traditional modes of teaching, yet the SCUP network was discussing the effect of new student-centred pedagogies on formal and informal learning environments. The facility manager saw this as an opportunity to experiment with a new kind of teaching space that would encourage a contemporary approach to teaching and learning:

> *"It doesn't seem to be right that we keep doing the same things over and over in the same way. You trick [learning spaces] up a little bit and get some efficiencies out of them ... but the process of teaching didn't seem to be pushing the boundaries"* (Facility manager).

As part of this congruent relationship, T1 and the facility manager collaborated to obtain funding for a new type of learning environment. This process fortuitously coincided with a new education precinct under construction. A space was identified as compatible with T1's requirements. The incumbent architects of the new education precinct were consulted to quickly design and document the new space so that it could be included within the program of new building works.

5.3 PEDAGOGY & DESIGN

5.3.1 How Did Pedagogy Inform the Design Process?

T1 inserted her own pedagogic doctrine into the concept of the DILE, previously described by T1 as the application of four elements: (1) immersion; (2) engagement; (3) risk taking and creativity; and (4) agency. T1 was conscious that the physical environment was intrinsically linked to her teaching and learning approach, which could not effectively be implemented in a computer laboratory or general teaching space. While T1 provided the educational vision in the context of a multimedia course, the pedagogical approach was intended to be equally relevant to a wide variety of disciplines. While the space was designed to meet the needs of a dynamic teaching and learning approach for multimedia, the facility manager considered it an experiment, stating:

> *"instead of just doing all teaching spaces in the same style, let's have a go at a prototype, something we can poke and prod and tweak around to see if this is the potential future of the campus"* (Facility manager).

Following discussion with T1, the approach to teaching and learning in the DILE was synthesised as:

1. enabling collaborative learning
2. reducing the emphasis on computer-based activities
3. promoting creative thinking and student learning initiatives.

5.3.2 Enabling Collaborative Learning

T1 believed that multimedia practice is essentially about problem solving, commonly experienced as a collaborative process of discussion, critical thinking and design. T1 planned for multimedia at Deakin to be delivered as a collaborative learning model, complemented with a lecture to address the theory of multimedia. Collaborative learning was impossible to implement in computer laboratories where desktop computers were present at a student ratio of 1:1, diminishing any opportunity for students to work in small groups:

> *"Given the nature of the [multimedia] industry in which these students, or my students work in, they have to do collaborative work. This design, or the design that I came up with, is premised on the assumption that students will have to work collaboratively. Actually students don't enjoy collaborative work, so that's the reason why there is a big emphasis on comfort, there's the couches, there's bean bags and stuff like that … Students don't like it; they actually learn to like it"* (T1).

T1 expressed that students did not always come to the multimedia course with a natural disposition for collaboration. In this sense, one of the objectives of the DILE was to provide an environment where students would learn to enjoy and embrace collaboration.

5.3.3 Reducing the emphasis on computer-based activities

T1 contended that considering multimedia as a primarily computer-based concept was fundamentally inaccurate, stating her aim was:

> *"to get [students] away from the computer; to understand that 95% of their work is conceptual and that the last 5%, the production of any digital media product, is at the computer; the last 5%"* (T1).

T1 was clear that computers should not be the focal point in the room, although students would be able to access computers or bring their own laptops.

5.3.4 Promoting Creative Thinking and Student Learning Initiative

T1 expressed the need for furniture and resources in the DILE to be mobile so that students could move elements around the room and therefore take control of their learning environment. It was important to T1 that students developed a sense of ownership; that they be able to choose how, where, when and with whom to undertake their learning activities:

> *"Students need to feel comfortable in the space; they need to feel that they own it. For me, that is one of the prime factors in the conceptualisation of the architectural space, was this sense of ownership. And the ability for things like furniture, and any of the other resources were movable, completely movable. So while I have an ideal of how the rooms would be set up, it's irrelevant. Because the minute that the students realise that they own the space, it facilitates their sense of ownership and learning as well. Hopefully with that sense of ownership comes a conceptual understanding of their own process. How do I best learn? How do I best access information? … I'm very concerned to ensure that students enjoy the process of learning; that they love it, that they embrace it, that they are completely immersed in it"* (T1).

By providing choices for students, T1 believed the DILE would intrinsically lead students to develop creative thinking skills, independence (from the teacher) and initiative, and in turn prepare them for work in the multimedia industry.

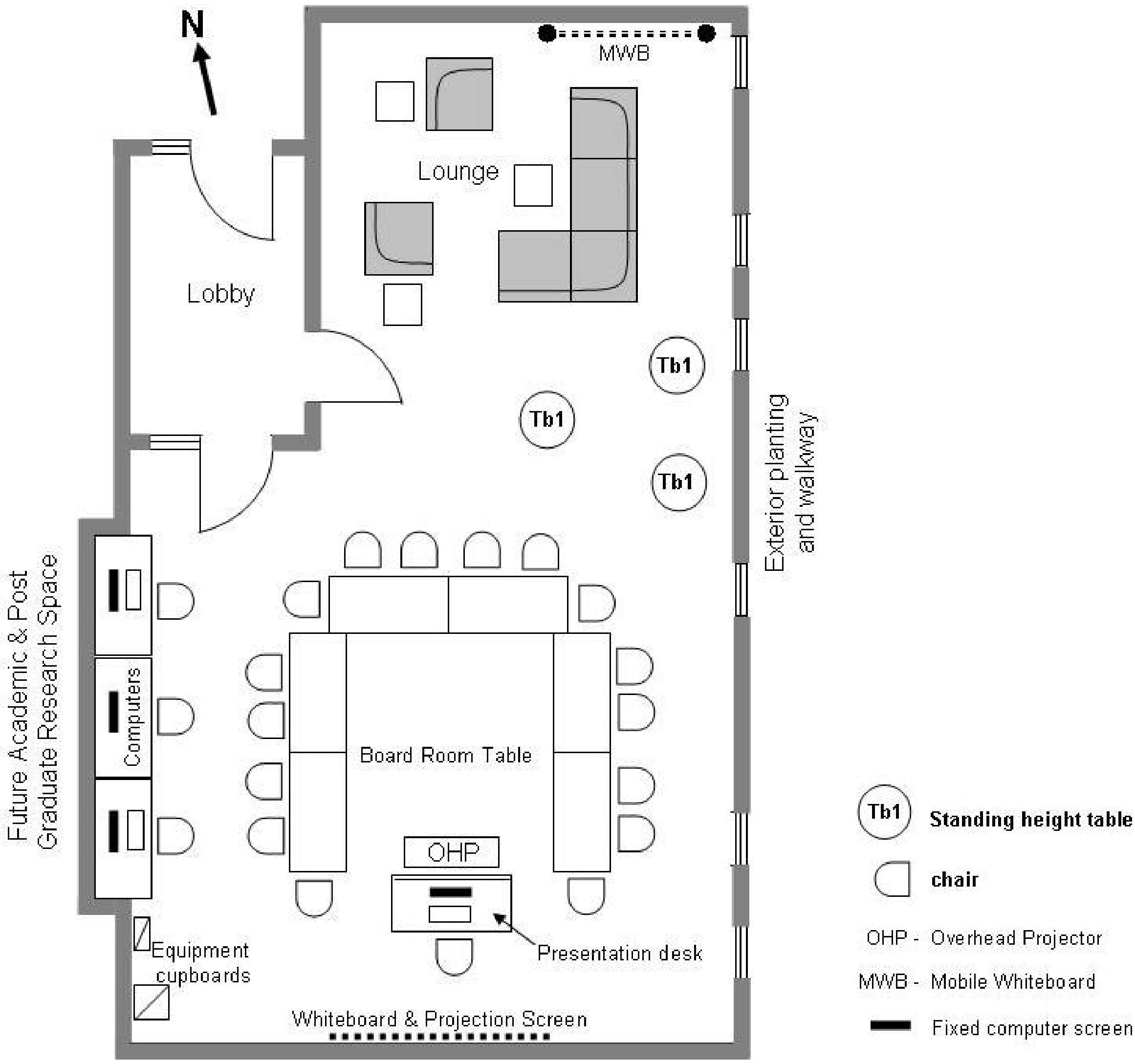


Figure 18: Furniture Plan, DILE

Figure 19: DILE: Lounge in the foreground, standing height (cafe) tables in the centre and boardroom table beyond.
Source: author.

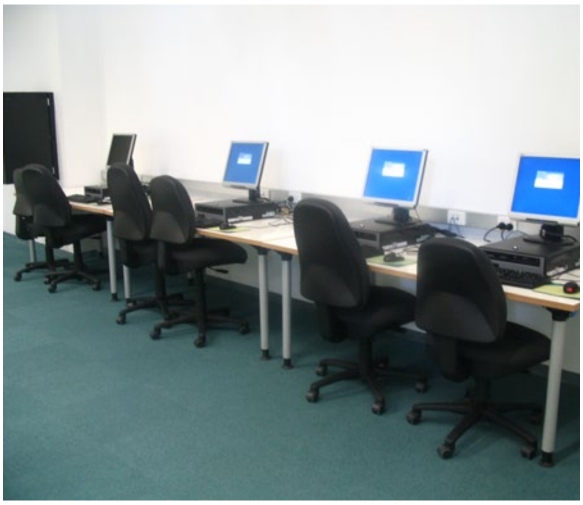


Figure 20: DILE Computer bench.
Source: author

Figure 21: DILE: Lounge in the foreground, standing height tables beyond.
Source: author

Figure 22: DILE Boardroom table setting with presentation desk to the left.
Source: author

5.4 ARCHITECT'S RESPONSE

The architect appreciated that the DILE space required a variety of settings to cater for a multiplicity of activities, interpreting T1's vision as a less formal classroom to encourage student creativity and interaction. T1's description of the teaching and learning objectives resonated with new types of learning environments the architect had seen elsewhere, particularly in the UK:

> *"When [T1] started relating those sorts of [teaching and learning] concepts we:*
> *a) knew what she was talking about and b) knew what the look of these spaces would be … The basis for the immersive learning lab was to: a) be flexible; and (b) it had multiple modes of learning … from a relaxed more individual-based approach, through to a more formal but still relaxed group approach—which was then obviously the higher tables—through to a more rigorous one-on-one approach so you could promote most of your pedagogies"* (Architect).

From the initial meeting with T1, the architect sketched a setting that responded to T1's philosophical and functional description of the teaching and learning that would take place in the DILE.

5.5 DESIGN FEATURES

With an area of approximately 100 m2, the 'L-shaped' DILE has a maximum width of 8.7 m and maximum length of 13.8 m (Figure 18). The ceiling is unusually high at approximately 5 m, to match the ceiling height of the campus gymnasium located at the opposite end of the building. A series of small, sporadically positioned windows puncture the western facade, and overlook trees that thinly mask the presence of the adjacent car park (Figures 19 - 22).

Finishes are basic and conform to the general teaching space standards, with white painted walls and carpet on the floor. Suspended fluorescent light fittings provide consistent lighting levels that accentuate the clinical ambience of the room.

The DILE was deliberately designed to comply with Deakin's finishes standards, primarily for ease of maintenance. However, as part of Deakin's risk analysis, the DILE was planned to be able to revert to a general teaching space if it failed to attract appropriate interest and use. As such, the capacity of the DILE was strategically set at 30 students, to align with the capacity of Deakin's stock of general teaching spaces.

The furniture settings form the critical elements of the unique functionality of the facility and differentiate this space from other general teaching spaces. There are four main zones within the DILE: the ‘boardroom table’, a ‘computer bench’, a ‘cafe’ and a ‘lounge’ (Figures 18 - 22).

5.5.1 The Boardroom Table

The boardroom table was conceptualised both as a large group setting for the whole class (Figure 23)—taking cues from a boardroom table in an office scenario—and a setting where multiple small groups could meet (Figures 24 & 25). A ‘presentation desk’ was not initially included in the concept design, but was added to conform to the audio visual standards enforced by the university. Problematically, according to the academics, the presentation desk gave the perception that it was the domain of the teacher, which somewhat contradicted the intentions of the space.

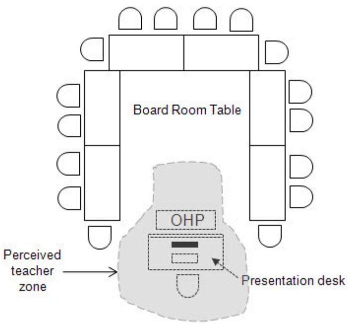


Figure 23: Boardroom Table, whole class discussion.

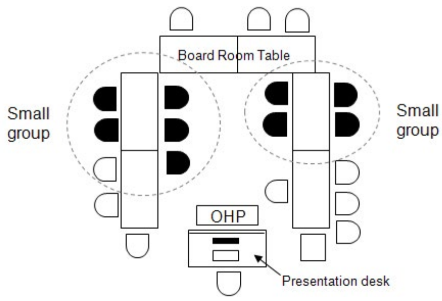


Figure 24: Boardroom Table, small group discussion.

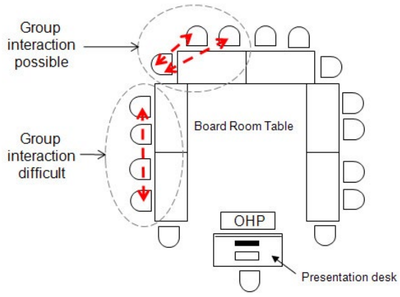


Figure 25: Boardroom Table, other interactions.

5.5.2 Lounge

The lounge was intended to inspire activities and behaviour such as creative thinking, brainstorming and problem solving (Figures 26 – 28), behaviours associated with higher cognitive learning skills (J. B. Biggs & Collis, 1982; Bloom, 1956).

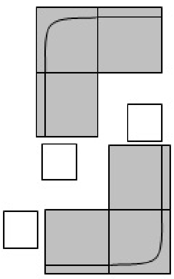


Figure 26: Lounge setting, arrangement A.

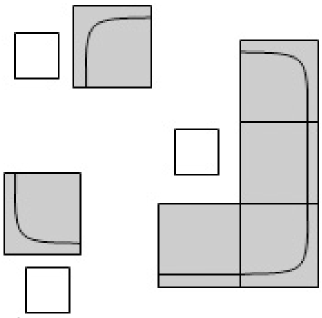


Figure 27: Lounge setting, arrangement B.

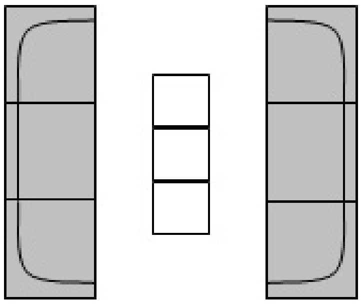


Figure 28: Lounge setting, arrangement C.

5.5.3 Computer bench

A bench for three computers was incorporated into the design, located along a wall that formed one short edge of the 'L', with a fourth computer located on the presentation desk. The computer bench was located to the side of the room and thus was not in a position that would dominate the space, reducing the emphasis on computers during class. The architect interpreted the purpose of the fixed computers as being for individual users undertaking individual tasks. The architect also understood that students were likely to bring their laptops into the DILE and that the space would be enabled for wireless computing.

5.5.4 Cafe

The standing-height tables originated from the idea of an internet cafe, where students could place a laptop for a quick group meeting. This setting was not seen as a site to work for long periods. The initial fit-out included a series of stools to complement the tables. However, the stools were stolen shortly after the space became operational and were never replaced.

5.5.5 Presentation desk

This element was required to meet strategic university objectives to streamline audio visual equipment throughout teaching spaces. It was conceptualised that a teacher could be allocated to any teaching space on campus and the audio visual system would be identical, increasing the efficacy with which teachers could implement presentational material.

5.5.6 Summary

In general, the variety of settings was planned to enable a multiplicity of asynchronous learning activities. T1 said:

> *"There would be the brainstorming, sitting on the couches, on the floor, talking. You'd have discussion; there are discussion areas and debate areas. There are areas for quick checking up on something, which is (sic) those tall tables that are meant to be able to hold a computer, where you just stand. Then there (is) the boardroom area, where you would sit to discuss as an entire unit, as a class"* (T1).

OBSERVATIONS:

- Pre-observations 1 & 2
- Osbervation 1
- Observation 2
- Pre-observation 3
- Observation 3

PRE-OBSERVATIONS 1 & 2

5.6 OBSERVATIONS:

5.6.1 Teachers's Orientation To Student-Centred Learning

The author was investigating whether or not the teacher was able to implement the TLAs as planned; hence the importance of conducting the interviews prior to the observations. During the observational studies the researcher was looking for evidence of the teaching and learning approach as described by the teacher, and evidence that the students were able to undertake the learning activities as planned by the teacher. Four teachers were interviewed and/or observed for this case study. Apart from T1 who was identified by the facility manager as the primary academic stakeholder, the other three teachers were selected on the basis that they currently teach or coordinate subjects conducted in the DILE.

While T1 provided the educational vision for the DILE, it transpired that she was not actively teaching in the facility during the period of data collection for this study. It would have been preferable to observe T1 in action, to ascertain how her teaching approach was applied in the DILE, but this remains one of the limitations of the study:

- T1 co-taught a third year multimedia subject with T3, in which T3 conducted the 'tutorial' in the DILE and T1 conducted a complementary lecture in a lecture theatre.
- T2 coordinated a first year multimedia subject, including planning the tutorial curriculum and weekly TLAs that were conducted in the DILE.
- T4 conducted the tutorials on T2's behalf.

T1, T2 and T3 were interviewed with regard to their experience of teaching in the DILE, and to discuss the teaching and learning intentions of the episodes to be observed.

While all teachers interviewed were from the School of Multimedia, the approach to teaching was distinctly different between the first and third year subjects.

PRE-OBSERVATIONS 1 & 2

5.6.2 Teachers T2 & T4 – First year

T2 expressed that the first semester of first year was partly about familiarising students with the process of collaborative learning. T2 adopted what she described as a constructivist approach to teaching and learning, the fundamental principles of which involved students 'learning by doing', by actively engaging with the learning content, the teacher and other students in the classroom. T2 was cognisant of the need for first year students to learn how to work collaboratively with their peers, to familiarise themselves with the type of working environment they will be experiencing in the future. Group work was introduced to students through small tasks to be completed during each week's tutorial:

> *"I've based it on a constructivist learning environment, or philosophy I suppose, and project-based learning … Teamwork, problem solving, peer review—working together collaboratively … I want them [the students] to get used to that idea, and that's how we work"* (T2).

In the first year classes, T2 provided the structure for each class, planning specific activities that T4 was to ensure were completed within the timeframe of each tutorial. It was expected that T4 would commence class with an address to all students. When the tutorial task had been briefed it was anticipated that small groups of students would find a space where they could discuss, implement and complete the task, before presenting their work to the whole class. In the first observation, one of the tasks would involve designing a typeface, which would most likely require access to a computer. The task in the second observation was planned to involve students experimenting with sound:

> *"I set them little mini projects in each studio. They have to complete something in each studio as a group … So in this particular unit today, we're doing stuff on text and typography. They start the session discussing the importance of it and legibility, readability … and then I'll get them to, in groups, come up with designing a typeface for a particular purpose"* (T2).

PRE-OBSERVATIONS 1 & 2

T2's description of the approach to the two classes to be observed, to be implemented by T4, indicated a strong disposition towards student-centred learning. T2 expressed a clear belief that students learn concepts and content deeply when they are actively 'doing' activities to reinforce learning, an approach T2 explicitly described as being founded upon constructivist principles.

5.6.3 Expectations

The following tasks and behaviours were anticipated:

- class would commence with students gathering around the 'boardroom table' where T4 would introduce key concepts and provide instruction on the activities to be undertaken
- some interactive discussion with the whole class, led by T4, prior to the activities commencing
- students would spend the majority of the class engaged in small group activities
- some activities would require use of the computers.

OBSERVATION 1

Table 6: *Observation 1 Timeline*

LEGEND

Black	Category 1, Teacher-directed
Grey	Category 2, Teacher-led interactive
Orange	Category 3, Student activity
Blue	Category 4, Student presentation
White	Start/Finish class

Date: TUESDAY, WEEK 3, SEMESTER 1, 4-6pm

Number of students: 9

Duration: 2 hours

TIME	ACTIVITY	FEATURE ACTIVATED
4:00 pm	– Class starts – T4 addresses class; discusses concepts from lecture; introduces 1st group task. Students all sitting at boardroom table – T4 located in area in middle of boardroom setting **(see Figure 29)**	Boardroom table
4:10 pm	– Students divide into two groups to discuss and respond to 1st task. Students remain at boardroom table for small group discussion – T4 moves from group to group to encourage interaction between participants	Boardroom table
4:20 pm	– T4 asks students to move to lounge for whole of group discussion regarding first task. (T4 said she moved students to the lounge in an attempt to engage students in the discussion, and because there was such a small group of students) – T4 stands to prompt discussion and seek responses from students (T4-a) – T4 unpacks topic and leads discussion, sometimes referring to projected information on screen at opposite end of room **(see Figure 30)**	Lounge
4:40 pm	– T4 moves location (T4-b), standing behind students on the lounge. T4 appears to move location to be near students who were talking to each other and not concentrating on discussion **(see Figure 30)**	Lounge
4:45 pm	– T4 moves location again (T4-c), standing behind students on the lounge. There is not a lot of interaction between students during the discussion; students are responding to T4 rather than to each other **(see Figure 30)**	Lounge
4:52 pm	– Teacher introduces 2nd task, discussing with students their knowledge of typefaces	Lounge
5:00 pm	– T4 introduces 3rd & 4th tasks, which will be carried out on computers – T4 provides information on how to work together, expectations and when they will re-group	Lounge
5:04 pm	– Everyone moves away from couches – One group (of four) reconvenes at boardroom table for a quick discussion, before moving to one of the fixed computers – The other group (of five) moves straight to the computer bench and splits across two computers – T4 moves behind student groups at computers, listening to their discussions and offering suggestions where appropriate **(see Figure 31)**	Boardroom table Computer bench
5:18 pm	– Group of four students moves from the computers to the mobile whiteboard at the rear of the room, for task 4 (designing a typeface) **(see Figure 32)**	Lounge
5:30 pm	– T4 instructs group of five to start on task 4	Lounge
5:50 pm	– All students move to the boardroom table and present their responses to all four tasks, to each other – T4 provides feedback to each group to confirm the strengths and weaknesses in their responses	Boardroom table Presentation desk
6:00 pm	– Class ends	Boardroom table Presentation desk

OBSERVATION 1

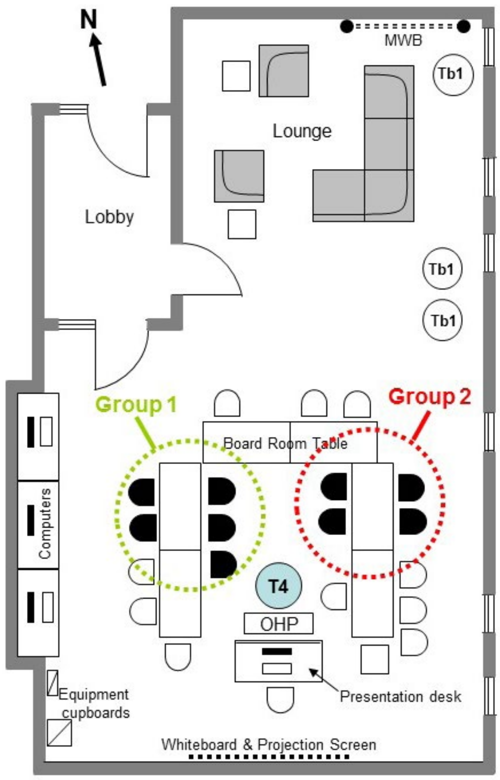


Figure 29: Observation 1, start of class

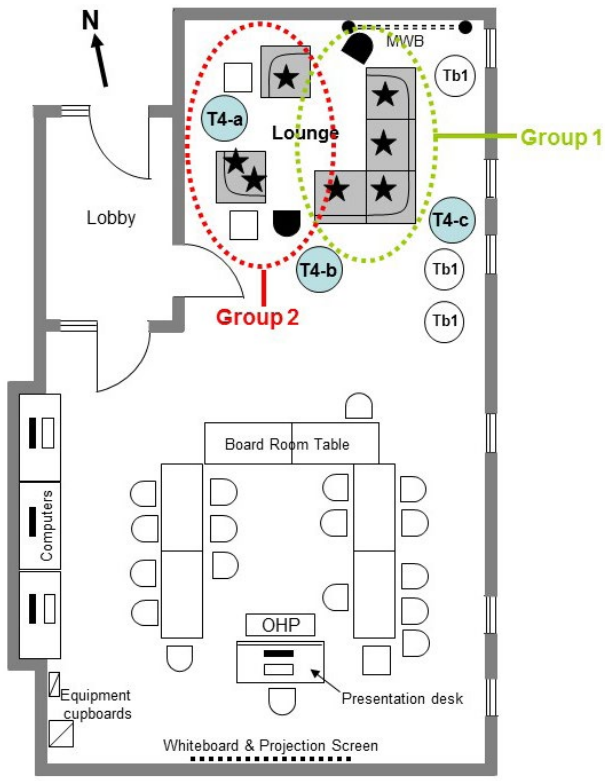


Figure 30: Observation 1, students and T4 relocate to the lounge for group discussion

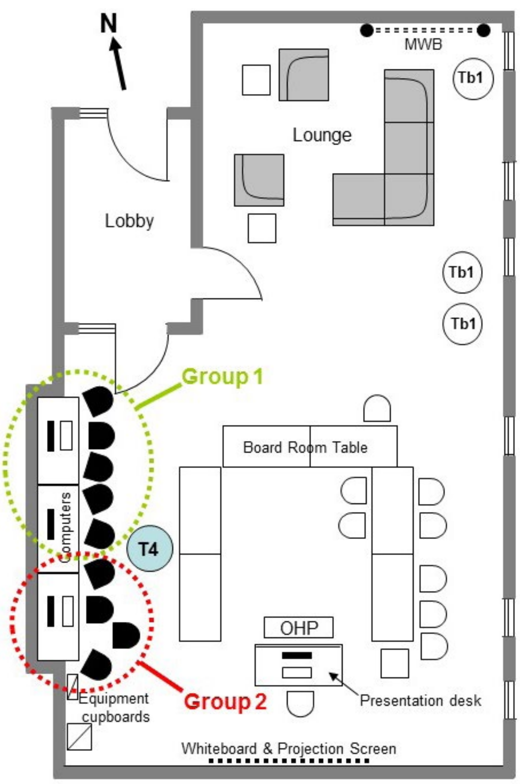


Figure 31: Observation 1, student activity

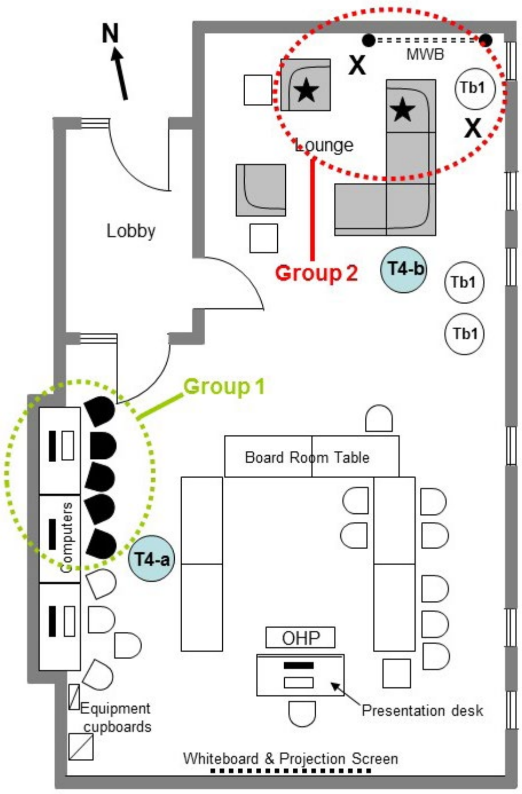


Figure 32: Observation 1, student activity

OBSERVATION 1

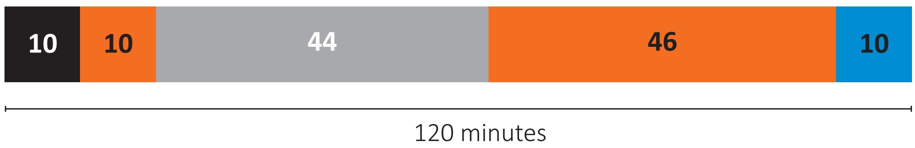


Figure 33: Observation 1 Timeline

	% Class Time
Category 1, Teacher-directed	**8%**
Category 2, Teacher-led interactive	**37%**
Category 3, Student activity	**47%**
Category 4, Student presentation	**8%**
Start/Finish class	-

Figure 34: Percentage of teaching & learning categories during Observation 1.

OBSERVATION 1

5.6.4 Summary Observation 1

There were only nine students in this class, although several more students were enrolled in that tutorial. T4 concluded the poor attendance was due to the perceived unpopular timing of the tutorial (4pm). There were two tutorials for this subject, one at 2pm and the other at 4pm.

All students commenced class at the boardroom table where T4 introduced a summary of key concepts relating to the previous lecture, using the presentation desk to project key points on to the projection screen. Teacher T4 also introduced the activities to be undertaken during that class. Some small group discussion occurred at the boardroom table, but then T4 instructed all students to relocate to the lounge for an interactive discussion. T4 indicated that relocating students to the lounge was to situate students in an informal setting in an attempt to encourage increased interaction and discussion.

It was apparent that T4 was able to elicit responses from students more readily in this setting. She was in closer proximity to the students, and moved around to make active eye-contact with students as they contributed to the discussion. Following the discussion at the lounge, students relocated to the computer bench to undertake the allocated tasks. For one particular task, one group relocated to the lounge to make use of the mobile whiteboard. Towards the end of class, Teacher T4 directed students to return to the boardroom table in order to have each group share the product of their activities with each other. The cafe tables were not used at all.

Over 50% of the class time was spent in a combination of 'student activity' and 'student presentation' (refer Figure 33). Less than 10% of time was spent in teacher-directed mode. Nearly 40% of the class time was 'teacher-led interactive'. This appears to be a significant period of time where the teacher attempted to engage students in discussion, although the students appeared initially reluctant to do so. This resonated with T2's understanding that first year students need to learn to interact and collaborate. The class structure demonstrated the hallmarks of a student-centred learning experience with a small proportion of teacher-directed teaching, some teacher-led interaction and the majority of the class dedicated to student activity and presentation.

OBSERVATION 2

Table 7: *Observation 2 Timeline*

Date: TUESDAY, WEEK 4, SEMESTER 1, 2- 4pm

Number of students: 16

Duration: 2 hours

LEGEND

(black)	Category 1, Teacher-directed
(grey)	Category 2, Teacher-led interactive
(orange)	Category 3, Student activity
(blue)	Category 4, Student presentation
(white)	Start/Finish class

TIME	ACTIVITY	FEATURE ACTIVATED
2:04pm	– Class starts. Everyone is seated at the boardroom table **(Figure 35).** – T4 summarised lecture and called for discussion/questions regarding lecture content. – T4 introduced tasks to be completed during class and divided students into groups by numbering them off into groups of four. The groups will be referred to as G1, G2, G3 and G4. – Two students arrived after class formally started.	Boardroom Table
2:14pm	– Everyone dispersed into four groups at the fixed computers **(Figure 36)**. – G1 used the presentation desk to access the computer. G2, G3 and G4 used the fixed computer bench. G4 utilised a laptop brought in by a student, not the fixed computer. – Activity included recording and editing sounds. – There is some interaction between groups. Everyone appears to be enjoying the task – having fun. – Even though the task is sound-based, the groups do not appear to be distracted by noise from other groups. – T4 moves from group to group to provide support; G3 is located on the centre fixed computer which is difficult for T4 to access. G3 gets less tutorial support from T4. – G1 temporarily moves to the lounge to record sounds, then moves back to the presentation desk.	Computer Bench Presentation Desk Lounge
3:20pm	– T4 requests students to complete their tasks as soon as possible. Some students move around the class to see what other groups are doing.	
3:35pm	– Student groups take in turns to present to the whole class, using computers and projection screen to display responses **(Figure 37).** – G1 and G3 presented from the presentation desk. G2 presented from fixed computer. G4 presented from laptop located on fixed computer bench. The audience twisted in their seats or swivelled their chairs to face presenters. – T4 provides feedback to each group as they present.	Boardroom Table Computer Bench Presentation Desk
3:50pm	– T4 summarises topic and generates whole of group discussion. – T4 calls for questions.	Boardroom Table
4:00pm	– Class ends.	

OBSERVATION 2

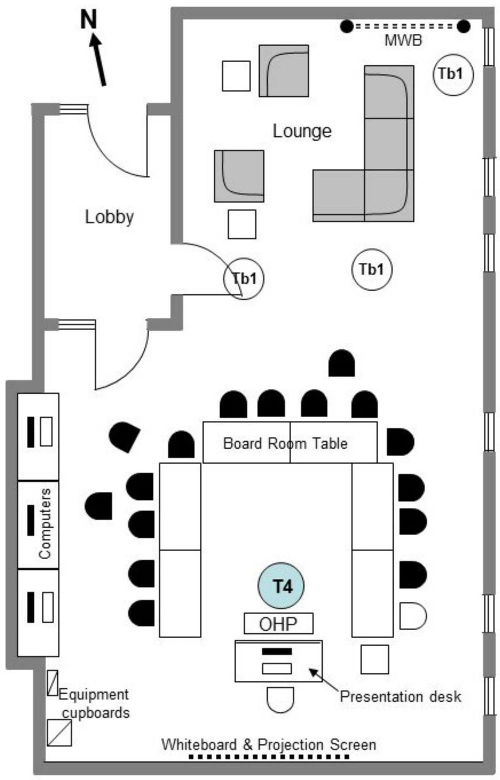


Figure 35: Observation 2, start of class

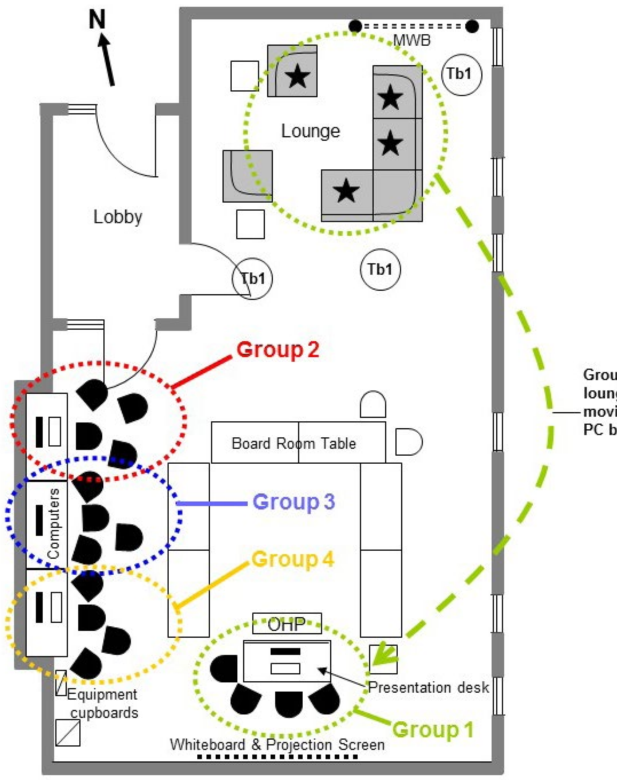


Figure 36: Observation 2, student activity

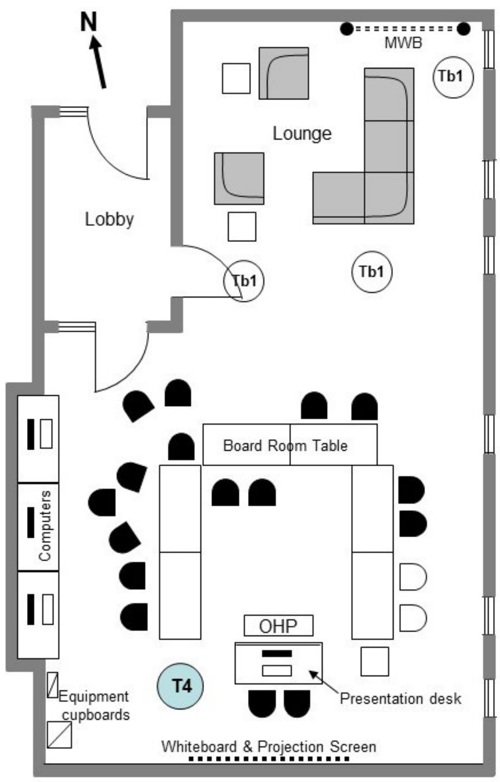
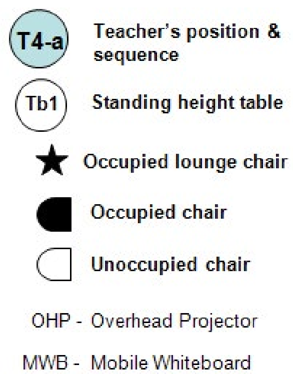


Figure 37: Observation 2, student presentation

LEGEND



OBSERVATION 2

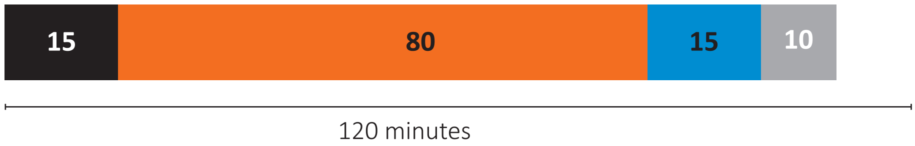


Figure 38: Observation 2 Timeline

	% Class Time
Category 1, Teacher-directed	**12%**
Category 2, Teacher-led interactive	**8%**
Category 3, Student activity	**67%**
Category 4, Student presentation	**13%**
Start/Finish class	-

Figure 39: Percentage of teaching & learning categories during Observation 2

OBSERVATION 2

5.6.5 Summary Observation 2

There were sixteen students in attendance at this 2pm tutorial, supporting T4's contention that this timeslot was more popular with students. Exactly 80% of class time was spent in a combination of 'student activity' and 'student presentation' demonstrating a highly collaborative and interactive approach to student learning (refer Figure 39). The teacher addressed the whole class in 'teacher directed' mode for 12% of the class time, similar to Observation 1. Less than 10% of the class time was 'teacher-led interactive'. This class looked and felt like the students had a high degree of autonomy in the space, and is what would be expected of a student-centred learning environment.

All students commenced class at the boardroom table where T4 addressed the class, using the presentation desk to project key points on to the projection screen. Teacher T4 provided instructions on the tasks to be undertaken by students, and then instructed students to establish their groups and proceed. As the task was primarily computer-based, the four student groups relocated to the computer bench. There were only three computers at the computer bench, leaving group 1 to utilise the computer on the presentation desk. Most of the students were located around the computer bench creating a high density of students and making it difficult for T4 to consult with group 3, who were on the central computer. Group 1 moved between the presentation desk and the lounge to undertake a specific activity, then relocated back to the presentation desk. Teacher T4 moved from group to group, as much as she was able, to consult on the progress of each group. Towards the end of class, T4 convened everybody back to the boardroom table for student presentations. Group 2 presented using a fixed computer at the computer bench. Groups 1 and 3 presented from the presentation desk, projecting their work on to the projection screen. Group 4 presented from a student-owned laptop located at the computer bench. Following the presentations, T4 led an interactive discussion to summarise what had been accomplished during the class and to briefly introduce the topic for the following week. The cafe setting was not used at any time.

As with the first observation, the class represented a student-centred learning experience for the students. Each setting, with the exception of the cafe tables, was used during the class, although the majority of student activity took place at the computer bench. This was surprising given the determination by Teacher T1 to reduce the emphasis of computers in the space.

PRE-OBSERVATIONS 3

5.6.6 Teacher T1 & T3 – Pre-observation 3 (Third year)

By their third year of studying multimedia, students were expected to have developed teamwork skills and knowledge of particular aspects of multimedia; in that sense the teaching and learning approach in third year was more self-directed. Students worked in groups of three to six people on a semester-long project that was presented and reported on at the end of semester. As a team, students managed their project, setting goals, dividing tasks, working through problems and implementing the project. The teacher was there to discuss issues as they arose and to assist groups if they appeared to be falling behind:

> *We expect students to have already picked up all the skills and knowledge in second year, and to now apply that knowledge and some project management skills in this unit. So my role really is to act as a mentor, and as an advisor and just help them go through the paces, not to engage with them and teach them new things. So it's very much an independent unit … I tell the students that if they are having trouble then of course I'm going to help them out, but I'm not going to walk them through the unit*. (T3)

In T3's third year tutorial the student groups worked at their own pace. It was up to students to plan what they needed to do in class, and then proceed with implementing that plan. Students were responsible for establishing their project, managing the scheduling, task allocation, weekly progress and problem solving, leading to the end of semester presentation. At Week 4 of semester, the third year students were expected to be working on project planning charts, requiring access to whiteboards, computers and in discussion with the teacher on the validity and progress of their project:

> *If I was to give them a script of [the subject], this is how I'd want them to follow it: to discuss [their milestones], discuss where they are at in terms of the whole project, maybe resolve some problems that happened during the week, or any questions the group members had. And then start working on at their next milestone.* (T3)

PRE-OBSERVATIONS 3

T3 displayed a strong disposition towards student-centred learning, demonstrating his awareness of students' prior learning and skill capabilities. Students had been afforded the freedom to define the content and scope of their semester-long assignment, negotiated with T3. It was expected that student groups would use the class time to advance their assignments, consulting with T3 to verify progress and seek assistance if required. As students would be working on varying stages of their assignment, it was anticipated that student groups might be distributed throughout the classroom with some groups accessing computers and others accessing whiteboards or clustered at the boardroom table. As multiple student groups would be working collaboratively at the same time, it was also anticipated that there would be a dynamic ambience of noise and activity.

OBSERVATION 3

Table 8: *Observation 3 Timeline*

LEGEND

(black)	Category 1, Teacher-directed
(grey)	Category 2, Teacher-led interactive
(orange)	Category 3, Student activity
(blue)	Category 4, Student presentation
(white)	Start/Finish class

Date: THURSDAY, WEEK 4, SEMESTER 1, 2- 4pm

Number of students: 11

Duration: 2 hours

TIME	ACTIVITY	FEATURE ACTIVATED
2:00pm	– No official start to class. Students arrive; they appear to sit in their groups and talk. Three fixed computers are being used by students. It is unclear if students are discussing their projects. – T3 is in discussion with 1-2 students.	Boardroom Table Computer Bench
2:15pm	– There are supposed to be 20 students in class, divided unevenly into five groups. – There are four apparent groups (G1, G2, G3 & G4), although G4 is the only person from his group present. **(Figure 40)** – G1 are in discussion around a fixed computer and briefly interact with the teacher. – G2 are working on a fixed computer together. They also appear to be making notes (not on the computer) and briefly interact with T3. – G3 are located at the boardroom table, all in a row, and appear to be chatting informally before starting to discuss their project. – Single G4 participant discusses with T3, what he can effectively do during the studio class.	Boardroom Table Computer Bench
2:30pm	– G1 discuss project with T3 and utilise two fixed computers. – G2 discuss project with T3 and also work on their Gantt chart, on a fixed computer. – G3 appear to be discussing project, but two students leave and do not return. Remaining two students do not appear to be working on their project. – G4 individual discusses project with T3 again. – Students generally stay in their initial locations, i.e. they do not move around the room. T3 moves around the room to access each group. – There is little evidence of groups interacting with other groups.	Boardroom Table Computer Bench
2:45pm	– G3 do not appear to be engaged in their project. – G4 individual appears to not be doing much; not talking to anyone else. He left the studio temporarily. – T3 advised the researcher that he recognised G3 were dysfunctional during that class, but resisted the urge to interfere, preferring to let them motivate themselves and make their own time management mistakes.	Boardroom Table Computer Bench
3:00pm	– T3 continues to discuss projects with groups as required. Many students leave early. T3 does not address the class as a whole at any time.	Boardroom Table Computer Bench
4:00pm	– Class ends informally	

OBSERVATION 3

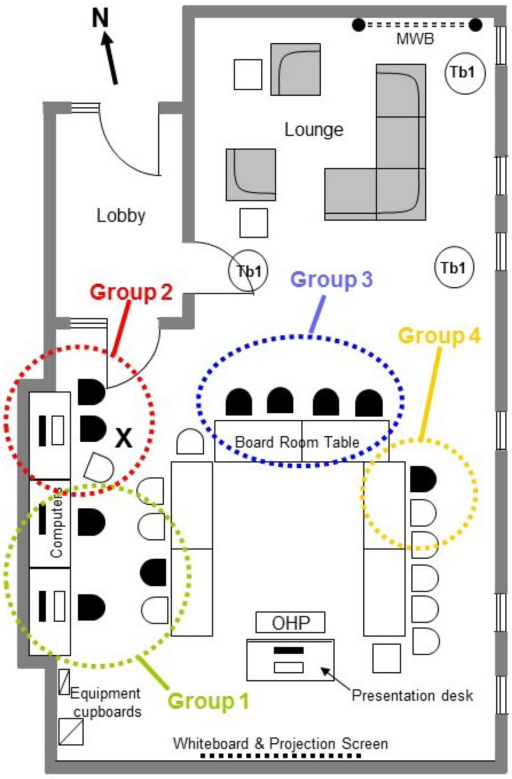


Figure 40: Observation 3, student activity

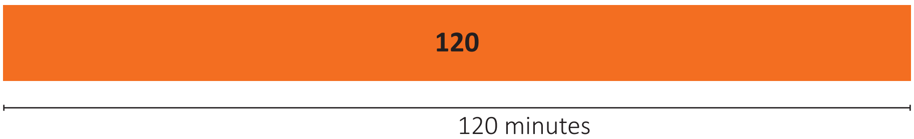


Figure 41: Observation 3 Timeline

	% Class Time
Category 1, Teacher-directed	**-**
Category 2, Teacher-led interactive	**-**
Category 3, Student activity	**100%**
Category 4, Student presentation	**-**
Start/Finish class	-

Figure 42: Percentage of teaching & learning categories during Observation 3.

OBSERVATION 3

5.6.7 Summary Observation 3

Twenty students comprising five groups were timetabled to this class. Only 11 students were in attendance. One whole group was absent and another group consisted of only one member. The entire class time was left to the students to organise themselves, discuss their group projects collaboratively and consult with the teacher when required.

T3 did not attempt to collectively address the students at any stage. Groups 1 and 2 worked at the fixed computers on the computer bench, although Group 1 members were working independently of each other, with one student located at the boardroom table. Groups 3 and 4 were located at the boardroom table. Group 3 members were lined up in a row along one side of the boardroom table, evidently making it difficult to conduct a collaborative conversation or activity. Despite the apparent awkwardness of group participants collaborating in a row, and the availability of alternative settings (i.e., a corner location of the boardroom table or the lounge, refer Figure 25), the students persisted in attempting to collaborate in a row.

None of the students used the lounge or cafe settings.

The students essentially remained in the same location throughout the duration of the class, except some students moved temporarily to speak to T3, before returning to their original location.

The single member of Group 4 consulted with T3 but left soon after.

Each group had a discussion with T3 and several students left early.

While T3 indicated that this was not ideal, he nonetheless refrained from ‘managing’ the students.

The class was surprisingly lacking in activity and dynamics, despite students having significant freedom in the classroom. As T3 had stated during the interview, he only planned to intervene in obviously dysfunctional groups if it appeared they would be unable to complete their project without his assistance. At Week 4, T3 considered it too early in semester to need to mediate. While students were expected to attend and be productive during the tutorials, it was clearly up to the students to do so. If the students did not optimise their tutorial time they would have to work harder outside class.

DISCUSSION

5.7 DISCUSSION

5.7.1 Design Features and Student-Centred Learning

The DILE was designed to address three key pedagogical intentions: a) enabling collaborative learning; b) reducing the emphasis on computer-based activities; and c) promoting creative thinking and student learning initiative. More specifically, first year teachers planned to implement a range of prescribed small group activities, some of which involved accessing computers. The third year teacher planned to allow students to use the space to suit their identified tasks. As a result of the observations it is possible to evaluate the degree to which the design of the DILE has satisfied these intentions.

5.7.2 Boardroom table

The boardroom table setting enabled large and small group collaborations. It was the pivotal point of the classroom where classes usually started and often ended. The teacher often signalled the beginning of class by providing a teacher-directed segment or teacher-led interactive discussion at the boardroom table, as a means of introducing the activities to be undertaken.

The third year class was an exception to this structure, as students were expected to continue with their major group projects from week to week, reducing the need for a weekly address from the teacher.

The boardroom table was suited to whole-class discussion as all students sat around the perimeter of the setting, facing each other. Small group learning was also possible, but more effective when students were located on either side of the individual tables, or across a corner, where better eye contact could be made. There were incidences of students attempting to collaborate along a row, which appeared less effective.

5.7.3 Lounge

Conceptually, the lounge was a setting where students could relax in an informal manner, which theoretically may stimulate creative thinking and student initiative. It was unclear, within the parameters of the present study, whether the lounge actually did stimulate creative thinking, although it was certainly utilised. The proximity of the lounge to the mobile whiteboard may also have been a factor in why student groups sometimes situated themselves there.

The lounge was observed being used in two different ways. One purpose was for one small group at a time to undertake a specific activity, with or without using the mobile whiteboard. The other purpose was for the teacher to conduct a teacher-led interactive session, to encourage greater participation by students. This was only possible with a small cohort of students. Otherwise the lounge was best suited to use by one group at a time. It was interesting to note that the third year students were not observed using the lounge at all.

5.7.4 Computer Bench

The location of the computers in one part of the room may have helped reduce the emphasis on computer-based activities; however, many of the learning activities required access to a computer. T1 initially intended that students should only spend approximately 5% of their time in class at the computer. The architect interpreted from T1 that students would undertake individual work on computers, not in groups. However, many of the observed learning activities required some computer intervention, and many (first year) computer-based activities were required to be undertaken in small groups.

Therefore, a high proportion of group activity occurred at the fixed computer bench where the computers were located close together, resulting in significant congestion in that part of the studio. The computer bench actually inhibited collaborative activities from taking place around the computers. There were times when the entire class was located in groups around each computer.

Apart from the congestion caused by students crowding around the computer bench and the audible distractions that this created, a further consequence was that it prevented the teacher from accessing many of the students to verify that they were undertaking the activity appropriately. When informed by the researcher that a lot of group work appeared to take place at the fixed computers, the architect replied, ‘it would have been good to have captured that in the brief’.

The issue of collocating the fixed computers appears to have been an oversight. Was it realistic to assume that multimedia students would only spend 5% of their time on the computer? Was it realistic that students undertaking collaborative activities would not need to use computers collaboratively? With hindsight, T1 explained “I would have done it differently. I would have had computers in key areas around the room to encourage group work”. Aiming to limit student access to computers does not necessarily work unless this is supported by an educational intention to limit the need for students to access computers in the studio.

5.7.5 Presentation desk

The presentation desk was described by the interviewed teachers as an unwelcome obstacle in the classroom, imposed upon the room's design based on university strategy to streamline audio visual equipment across campus. While it may have been perceived as an obstacle in the room, creating the perception of a teacher 'zone' at the front of the room, there were occasions when students were observed accessing the computer on the presentation desk, without any apparent awkwardness. It is possible that the perception of the presentation desk as a distraction from student-centred learning was limited to the teacher.

5.7.6 Cafe

The standing-height tables that were conceptualised as an 'internet cafe' setting where students could quickly meet around a table, were not observed being used at all. It appeared that this setting had not been particularly successful at enabling collaborative learning, deemphasising the importance of computers, or encouraging creative thinking. This may have been due to the lack of stools to sit on and the lack of accessible power.

5.8 ALIGNMENT WITH THE EFFECTIVE TEACHING AND LEARNING FRAMEWORK

How do these observations and insights align with the Effective Teaching and Learning Framework? Has the Deakin Immersive Learning Environment (DILE) enabled effective teaching and learning?

The DILE classroom incorporates a range of different settings for different teaching and learning activities. It was evident that each teacher could move around the room to engage with students individually, in small groups, as well as facilitating whole class discussions, making it possible to build meaningful relationships with students and understand their perspective (Element 1). This was, however, made difficult in the area around the desktop computers, where student groups were clustered around each computer making it difficult at times for the teacher to access the students. While there was a range of educational technologies available in the classroom, clustering the desktop computers was problematic. A fourth desktop computer – the primary computer for whole of class presentations located at the front of the classroom – was encouraged to be used by students. However, this computer did not appear to be as popular as the cluster of PCs off to the side, potentially as it was located at the front of the room. One mobile whiteboard was accessible in the room, however only one group could use the whiteboard at a time, resulting in an inequitable situation that potentially disadvantaged students who were unable to access the resource during class. There was a fixed whiteboard located behind the drop-down projector screen and rendered unusable as the projector screen was in continuous use throughout class. Even though there was considerable vacant wall space for additional writeable surfaces, the walls were left blank.

Students were viewed interacting collaboratively with each other. It was evident that some interactions began at a social distance, primarily at the boardroom table, progressing to interactions at personal and intimate distances (Element 2). Activities at personal and intimate distances occurred at the lounge and desktop computers, as well as at the boardroom table.

During observations 1 & 2 students were working at their own pace, even when task deadlines existed. While the DILE furniture was not easily moveable there was at least one instance of students moving the lounge furniture into a configuration to suit their brainstorming activity around the mobile whiteboard. It was also evident that different learning activities were able to take place at the same time. For example, a group of students were observed working at a desktop computer, while another group conducted a discussion at the boardroom table and another group used the mobile whiteboard. These observations are symptomatic of students spending time on task, engaging collaboratively in a deep approach to learning and increasing independence as learners (Elements 3 and 4).

Teacher T4 was observed relocating students to the lounge chairs in order to increase interactive discussion. The teacher had an awareness the students needed to know a particular concept critical to their coursework and their lack of engagement at the boardroom table suggested a lack of prior knowledge (Element 5). By moving students to the lounge, T4 was able to yield a more interactive discussion and affirm their level of knowledge on the topic.

Each of the teachers were observed providing feedback to their students (Element 6). They did this in a number of ways. Most commonly the teachers spoke to each collaborative group to ask and answer questions, gauging the student's progress and addressing any issues. Observations 1 and 2 included time towards the end of class when each student group presented their task responses to the whole class. The teacher provided immediate feedback to praise what was done well and critique where improvements could be made. Teacher T3 was observed interacting with groups of third year students to support their semester-long assignment. Several students did not attend class, the potential implication of this being that absent students did not need T3's feedback. T3 expected that higher attendance would prevail towards the end of semester, closer to when the assignment was due.

5.9 CONCLUSION

The DILE is a single classroom with five different furniture features: 1) the boardroom table; 2) the lounge; 3) the café; 4) the desktop computers; and 5) the presentation desk. The boardroom table, lounge and desktop computers were used very effectively, despite the congestion that occurred as a result of the desktop computers being located too close to each other. The café tables were barely used at all and not considered a successful feature of the room. The presentation desk was used primarily by the teacher even though students were given permission to use the desktop computer located there. The perception of the front of the room as the 'teacher's domain' may have been a detractor from greater use.

The design of the DILE evolved from a clear endeavour to change the way multimedia was being taught at Deakin University, from a computer-based experience to a collaborative and interactive learning experience that would better prepare students for the workplace. The DILE has evidently enabled collaborative learning to take place. First year students were learning to collaborate in the DILE, whereas by third year, students had a greater understanding of how to collaborate, including how and when to use the classroom. The pedagogical vision was led by T1 and supported by T2, T3 and T4. T1 and T2 in particular described how the DILE enabled them to facilitate their preferred collaborative teaching and learning style. Overall, effective teaching and learning behaviours were demonstrated throughout the three observations. Although the physical environment presented some challenges in terms of equitable access to computers and other resources, as well as the potential to increase 'active walls' to enhance student activity during class, the DILE classroom is symptomatic of a new generation learning environment that enables effective teaching and learning.

Chapter 6 - Case Study 2: Collaborative Learning & Teaching Centre (CTLC), University of Queensland

6.0 INTRODUCTION

The CTLC at the University of Queensland was a pioneering example of a NGLE when completed in 2008. Rather than a single space with a specific disciplinary focus, the CTLC is a conglomeration of large and small classrooms designed for all faculties to access for the specific purpose of fostering collaborative learning.

The outcome has been described as 'accidental' (Andrews & Powell, 2009; Jamieson, 2005) in the sense that there was significant uncertainty during design around whether the completed facility would meet teachers' and students' needs. While the broad intention of enabling students to work in groups was understood and keenly supported, the operational reality of what this meant for activities, processes and resources was only vaguely articulated. However, it is perhaps because of the absence of a clear pedagogical and design brief to the architect that the project is uniquely experiential.

The CTLC was symbolically important to the Australian higher education community because of the valuable lessons that have been drawn from its creation and operation. The University of Queensland opened the CTLC's doors to the higher education community portending a series of major research projects that prioritised learning spaces, laying the foundation for a vibrant discourse connecting educational theory with the design of learning spaces (Carrick Institute, 2007; Radcliffe, 2006; Radcliffe, Wilson, Powell & Tibbets, 2008).

Evaluation of the CTLC included two groups of participants: 1) key project stakeholders involved in the design and procurement of the precinct; and 2) academics who taught in the CTLC. The key project stakeholders were:

- the architect
- the AVM
- the LED
- five academic participants (T1–T5), representing a variety of faculties and year levels
    - T1 & T2 were team teachers in a first year subject for the Faculty of Science
    - T3 taught in a fifth year veterinary science subject
    - T4 taught in a first year health science subject
    - T5 taught in a third year Faculty of Science subject.

The LED's role at the University of Queensland was to support the development of professional academic programs through the Tertiary Education Development Institute (TEDI) and extended to advising on the educational use of the CTLC as a result of his experience designing a PBL precinct at his previous place of employment. The primary academic stakeholder was the then Deputy Vice-Chancellor (Academic). However, at the time of this study she had moved to another university and was unable to participate in this study.

6.1 UNIVERSITY CONTEXT

The University of Queensland's *Teaching and Learning Enhancement Plan for 2003–2007* (Gardner, 2004) explicitly aimed to provide collaborative learning spaces in response to Professor Gardner's concern that "the existing teaching and learning space facilities at UQ [University of Queensland] did not adequately support collaborative pedagogies" (Tibbets, 2008). It was in this context that the CTLC was designed. Named the Sir James Foots building, construction was completed in 2005.

The CTLC (Building 47A) is located at the university's St. Lucia campus, situated on the southern edge of the academic precinct, opposite the residential colleges and nestled between the Axon Building (47), the Chemical Engineering Building (74) and Hawken Engineering Building (50) (see Figure 43).

Figure 43: University of Queensland campus plan 2008.

The CTLC is an L-shaped, two-storey building positioned along a primary east–west axis. The main concourse looks out into a sheltered northern courtyard landscaped with tropical native vegetation, providing a peaceful refuge. The southern perspective pleasantly looks out across parklands to the residential colleges. A cafe located on the ground floor at the eastern end of the building generates a social ambience that filters into the building.

6.2 PEDAGOGY AND DESIGN

6.2.1 How did pedagogy inform the design process?

The concept of collaborative learning was a key driver of the design of the CTLC, albeit with difficulty as the project control group and architects struggled to interpret what collaborative learning should look like in a classroom setting. The architect conveyed the briefing process as an iterative process with the project control group, stating:

"*I have to say no one really knew what we were doing. We'd do something and they'd react and they'd say something we'd react to that. So it just sort of developed that way. It wasn't a common language and that's something that we identified late is a subliminal problem.*" (Architect)

The LED and AVM arrived to new positions at the University of Queensland at around the same time, at which point the construction of the base building was well under way. Synergies between the LED and AVM began to emerge as they discussed, imagined, scripted and storyboarded how teaching practice could unfold in the space, and how technology could be incorporated to enhance the collaborative teaching and learning experience:

> *"I would often say to [AVM] in various settings, this is how I imagine the class to be run and I would try to give him an accurate description, and over time he started to see a pattern of performance and behaviour in a teaching and learning sense that we were able to break down into a menu of three behaviours ... that became the organisational mechanism for making the room work"* (LED).

These three behaviours became known as the operational modes of the space: 'seminar mode', 'pod mode' and 'individual mode' ('feedback mode' was a later addition). Each mode had an educational 'story' that had been imagined and then scripted by the LED and AVM. They worked with the architect to actualise the educational vision into the classroom spaces, incorporating theatrics and drama to differentiate each mode. As the technology ideas progressed, the question arose as to how many computers should be installed in each classroom. Tension existed around the idea of the classrooms having the dual function of computer laboratories during open access (non-timetabled use); however, this was concept was resisted by Professor Gardner and the LED (Jamieson, 2005). The LED intended to 'encourage collaborative use of technology', which resulted in establishing a ratio of one computer per three students.

While each of the classrooms—large and small—was designed for a particular educational narrative, enabled by the distinctive operational modes and ratio of computers, significant concern was focused on the large classrooms and how collaborative learning would work in such a large environment. Room 241, as one of the large classrooms, was divided into five pods, each with the capacity for 18 students (refer Figures 44 & 46). It was unclear how 18 people were expected to work collaboratively together in each pod, or how smaller groups would share the technology resources. By the time this was flagged as a potential problem, the building program could not sustain any delays to resolve the issue and the building was completed with some concern for how the large groups of 18 would work in each pod.

The smaller rooms (Rooms 351 & 352, refer Figures 45 & 52) were simpler to orchestrate educationally as they were not constrained by 'pod' sizes. The single spaces did not have the same theatrical response to the different operational modes, although the technology was planned to work in the same way as the large classrooms.

The educational narratives and technological support developed by the LED and AVM to support collaborative learning provided clarity around the spaces that had already been designed. However if their intervention had occurred earlier in the design process, the large classrooms may have resulted in an entirely different structure.

6.2.2 Architect's response

The base building had originally been designed with two floors of general teaching spaces. However, the brief changed when Professor Gardner endorsed the inclusion of spaces for 'flexible' teaching and learning. By the time this decision was made the building template had been confirmed, resulting in two particularly large spaces that became the large collaborative classrooms, Rooms 241 and 341:

> *The brief was, from the very beginning, very loose. The parameters were that [the project control group] didn't want any more of the same sorts of teaching spaces but they didn't actually know what they wanted.* (Architect)

While the architect understood that the classrooms were to enable collaborative learning, there was very little clarity around what this meant spatially and behaviourally. The project control group was unable to define optimum group sizes or conceptualise the range of activities that should be made possible within a collaborative learning framework, although computer-based activities were acknowledged. The architect was not aware of other examples of collaborative learning environments, therefore his concept of collaborative learning was primarily informed by his experience of designing university libraries.

The architect described the iterative design process to the author, recounting that:

no one really knew what we were doing. You know, we'd do something and they'd react to it. They'd say something and we'd react to that. So it just developed that way. (Architect)

Professor Gardner expressed, 'I knew that it wasn't all about IT [information technology]. We had one group that thought it was the equivalent of a big computer lab and we had real problems dislodging that idea from peoples' heads'. (Jamieson, 2005).

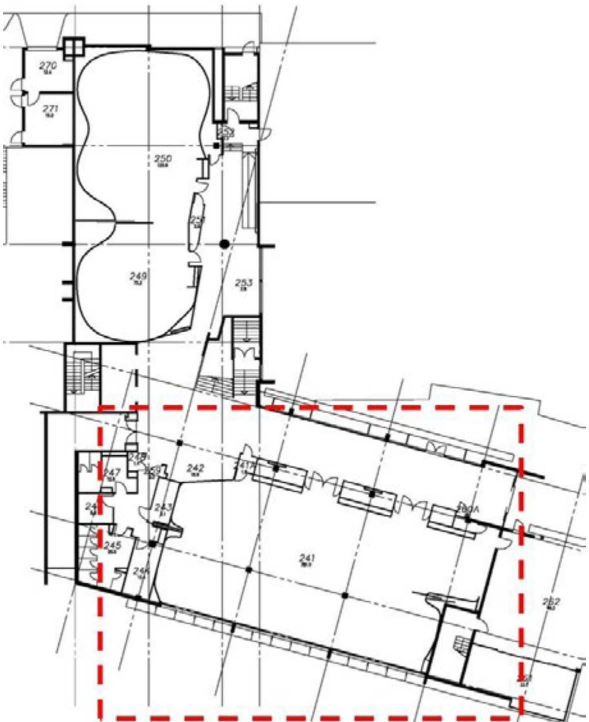


Figure 44: CTLC, Level 1 Floor Plan, Room 241
Architects: Wilson Architects
Source: Wilson Architects

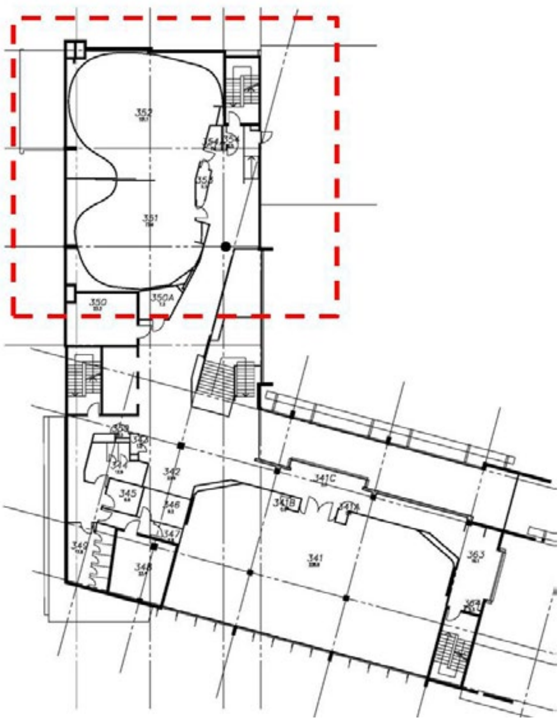


Figure 45: CTLC, Level 2 Floor Plan, Rooms 351 & 352
Architects: Wilson Architects
Source: Wilson Architects

The architect conceptualised an experiential approach to the classrooms, creating ambient differences between the larger and the smaller spaces. The architect articulated the primary difference as the large classrooms being 'noisy' and the smaller classrooms being 'quiet'. This was afforded by the large classrooms having access to abundant natural light, making them bright, dynamic spaces. The smaller classrooms were designed to be the inverse of that experience, by creating darker spaces without any natural light, creating cave-like qualities:

> *We wanted that [large classroom] to be bright because we sort of saw that as the noisy room and this [small classroom] was the quieter room and we wanted to have a space that would encourage that sort of behaviour. So that was reasonably conscious because that was directly feeding off our library work, that you could create spaces that could shift people's experience and they engage with the learning process ... This is a premise that we had: active and quiet. Not that we understood it in terms of teaching and learning but anyway, there was an idea … So this [small classroom] has a different feel about it and we quite liked the idea of it being organic. I guess that might have been reacting to this structured format that [the project control group] were quite keen to avoid.* (Architect)

Despite the lack of pedagogical direction from the project control group, the architect knew from his experience designing university libraries that the ambient qualities and theatrics of space could shift a person's awareness of the environment, enabling them to change their educational focus. This formed the basis of the architectural response. The LED and AVM worked with the architect to bring greater clarity to the educational vision through the intervention of innovative furniture and technology concepts, which developed into the idea of 'pods' to spatially define student groups and technology 'modes' to define TLAs.

6.3 DESIGN FEATURES

6.3.1 Size & Finishes

The CTLC is a major precinct dedicated to collaborative learning. It incorporates six learning spaces: two large classrooms each with a capacity of 90 students and four smaller classrooms varying in capacity from 15 to 40 students. This study focuses in particular on one of the large classrooms, Room 241 (Figure 46) and two smaller classrooms, Rooms 351 and 352 (Figure 52).

Room 241 contrasts with Rooms 351 and 352 physically and atmospherically, but both types of space aim to promote student-centred learning by enabling small group learning. Apart from the difference in capacity (Room 241 = 90, Room 351 = 15, Room 352 = 30), the large classroom is open, transparent and bright (Figures 47 & 48), while the smaller classrooms are enclosed, cave like and dark (Figures 53 & 54).

Room 241 is approximately 343 m2, with a length of 28 m and width of 13 m, located on the ground floor (refer Figure 46). The ceiling height is approximately 2.7 m. The floor is carpeted, walls are painted white and the southern windows offer a pleasant view. There are two main points of entry/exit into the room and a third doorway directly accessing the cafe, although this thoroughfare is not utilised. The walls are rectilinear, although the furniture layout is curvilinear. Approximately 30 fixed desktop computers are positioned along benches around the room, although the university does not identify it as a computer laboratory.

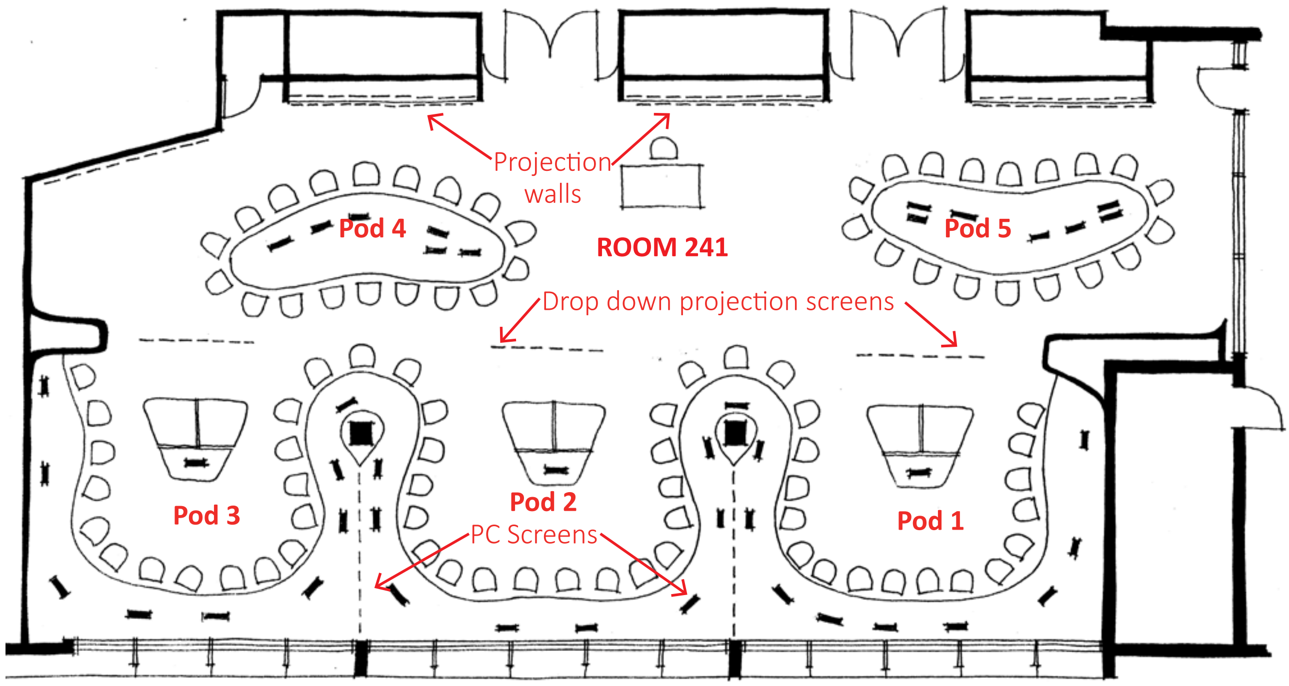


Figure 46: CTLC, Level 1, Room 241 Furniture Layout
Source: Author

Figure 47: CTLC, Room 241
Source: Author

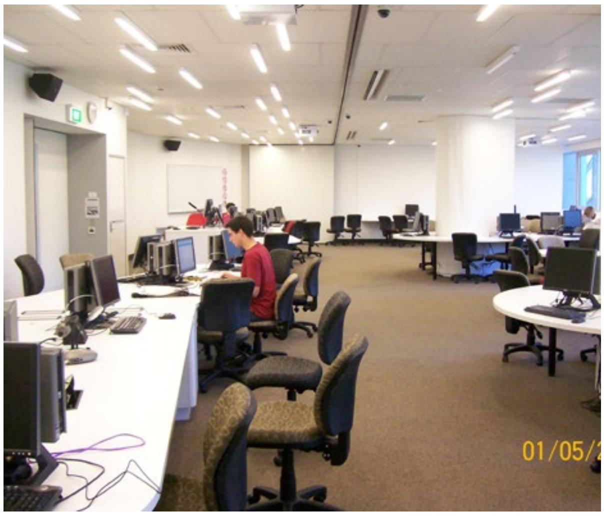


Figure 48: CTLC, Room 241
Source: Author

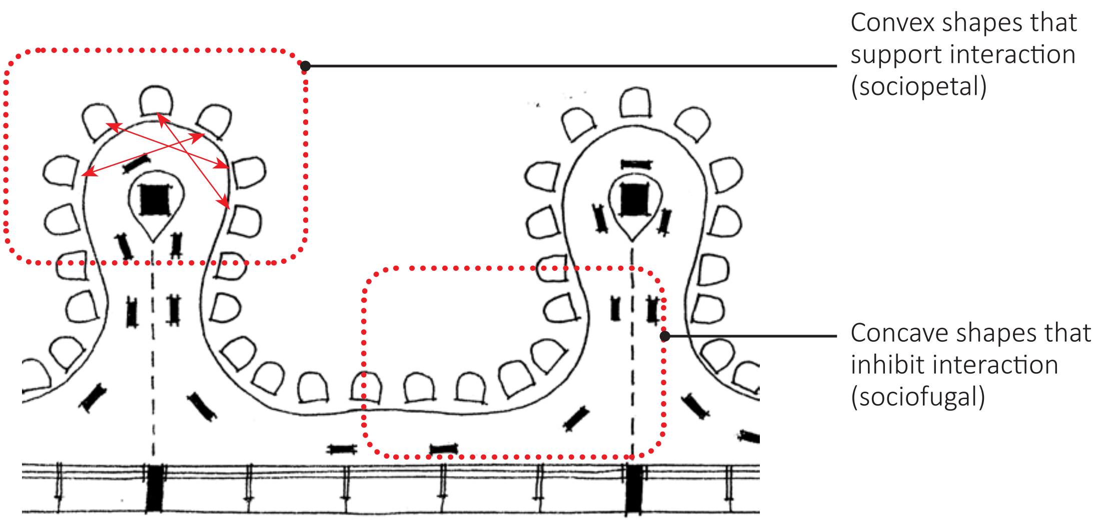


Figure 49: CTLC Room 241, Sociopetal and sociofugal settings in pods 1, 2 & 3
Source: author

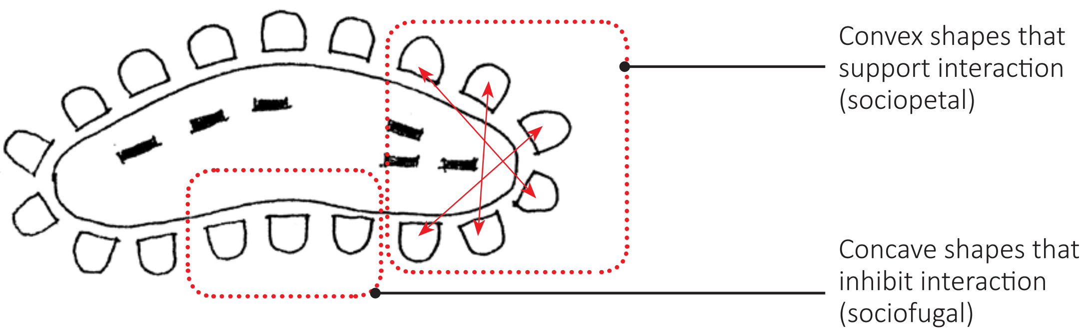


Figure 50: CTLC Room 241, Sociopetal and sociofugal settings in pods 4 & 5
Source: author

Located on the second level, Room 351 is approximately 86 m2 and Room 352 is approximately 128 m2 (refer Figure 52). The rooms operate separately but are divided by a sliding partition that can be retracted to expand into a single large space. The ambience is entirely different from that of Room 241. There is no natural light; no external outlook. The walls of Room 352 are lined with acoustically treated timber panels, whereas Room 351 is lined with painted white plasterboard. The walls are organically curved to envelop its occupants in a cave-like atmosphere. Benches housing desktop computers line the perimeter of both rooms, with loose mobile tables and chairs located in the central floor space. A small number of LCD screens is mounted on the walls around Room 352 to ensure students have visual access to presentation material no matter where they were sitting.

6.3.2 ROOM 241

Room 241 was designed as five distinct furniture zones—or pods as they were known (Figure 46)—with each pod seating 18 students. Pods 1, 2 and 3 are located in U-shaped configurations along the external glazed wall, while pods 4 and 5 are located internally and are defined by long boomerang-shaped tables. A central lectern indicates the teacher's domain and multiple ceiling-mounted projectors begin to suggest an environment rich in technology. Each pod is defined by a series of working benches and tables that house fixed desktop computers, at a ratio of one computer per three students. Three pods consist of organically shaped convex and concave structures that facilitate contrasting learning behaviours, described by Hall as sociopetal and sociofugal furniture settings (Hall, 1970). The two boomerang-shaped tables that define pods 4 and 5 also present edges shaped for sociofugal and sociopetal behaviour. The concave shapes are sociopetal settings, which tend to bring people together: for example, students can meet around curved edges for collaboration and interaction. Convex shapes of sociofugal settings are better suited to students working individually at computers (see Figures 49 & 50). The architect was cognisant of these relationships, describing that:

> *one was meant to be in a concave arrangement where you were working at the computer and quite close to it and the other one was a little bit more extrovert, sort of out on the floor and we were quite conscious of that.* (Architect)

Located in the centre of pods 1, 2 and 3 are mobile meeting tables for students to sit around. One desktop computer is located on each table to enable student control of a local data projection system.

What is not immediately apparent, however, is the chameleon nature of the space. The room was designed to operate in four pedagogically different 'modes': seminar mode, pod mode, feedback mode and individual mode. All modes are controlled at the central lectern, and at the initiation of each mode the room dramatically transforms. The default position for Room 241 is individual mode: the lights are all on and the windows are visible and transparent. In this state the room invites students to work individually or in small groups, whether using the computers or not. When the room is not timetabled, students have open access without requiring supervision from a teacher.

When a teacher or student wishes to conduct a presentation or mini-lecture, seminar mode can be initiated: blinds extend to cover all windows simultaneously; the room darkens with banks of lights being turned off; lights focus on the lectern; the front-facing projectors light up projection walls. All of this happens synchronously within seconds, at the touch of a button at the lectern.

Teachers are encouraged to instigate group work, which can be enhanced by switching the room setting to pod mode. Again, at the press of a button, the lights are turned on, the blinds remain in their closed position and multiple screens extend from ceiling cavities to partially subdivide the room, in particular creating visual separation between pods 1, 2 and 3 (Figure 51). Pods 4 and 5 are considered appropriately isolated from each other to avoid visual or audible distraction between groups. In these settings students can work in small groups by engaging in a range of activities from discussion to computer based, or cooperatively utilise the local data projector to access network-based resources and presentation software.

Figure 51: CTLC Room 241, Pod & Feedback Mode
Source: Peter Jamieson

The teacher can move from pod to pod, supervising and facilitating as required, but if they wish to share the product of a particular pod with other students, the teacher can activate feedback mode. For example, work projected on a screen in pod 2 can be shared with the whole class by beaming to the projected screens in each pod. The teacher and/or students can then facilitate a discussion before reverting back to pod mode. The pedagogical flexibility of the room has been enabled by the design of the technology systems and enhanced by the transformation of lighting, blinds and screens.

Therefore, the defining features of Room 241 are:

1. the pod concept grouping students into five defined zones
2. the technology system that provides four distinct teaching and learning modes
3. the dramatic ambient changes to the room associated with each mode of learning.

6.3.3 ROOMS 351 & 352

These rooms share many attributes: the walls are organically concave and they have identical finishes and furniture and similar ceiling design (refer Figures 53 & 54). They both feature a lectern that is a standardised element throughout each classroom in the facility. They differ in their capacities, but the primary differentiation is in the type of technology provided within. As if experimenting between two types of technology, one room is equipped with multiple data projections while the other is fitted with multiple wall-mounted LCD screens. In each case the screens are controlled from the lectern and can operate synchronously or asynchronously. Both rooms have multiple fixed desktop computers located around the perimeter.

Two types of mobile tables furnish the central space of each room. Large curvilinear triangle-shaped tables with faux timber veneer finish comfortably seat up to nine people. Small kidney-shaped tables finished in bright red laminate suit a small group of three or four people. Room 351 has one large table and three small tables and Room 352 has two large tables and two small tables, but these elements are interchangeable between classrooms depending upon demand and purpose. The retractable wall separating the rooms is lined with whiteboard panelling, albeit at an awkward height and size in a determination to align with the geometry of the wall panelling. One wall-mounted whiteboard is also located conventionally in each room.

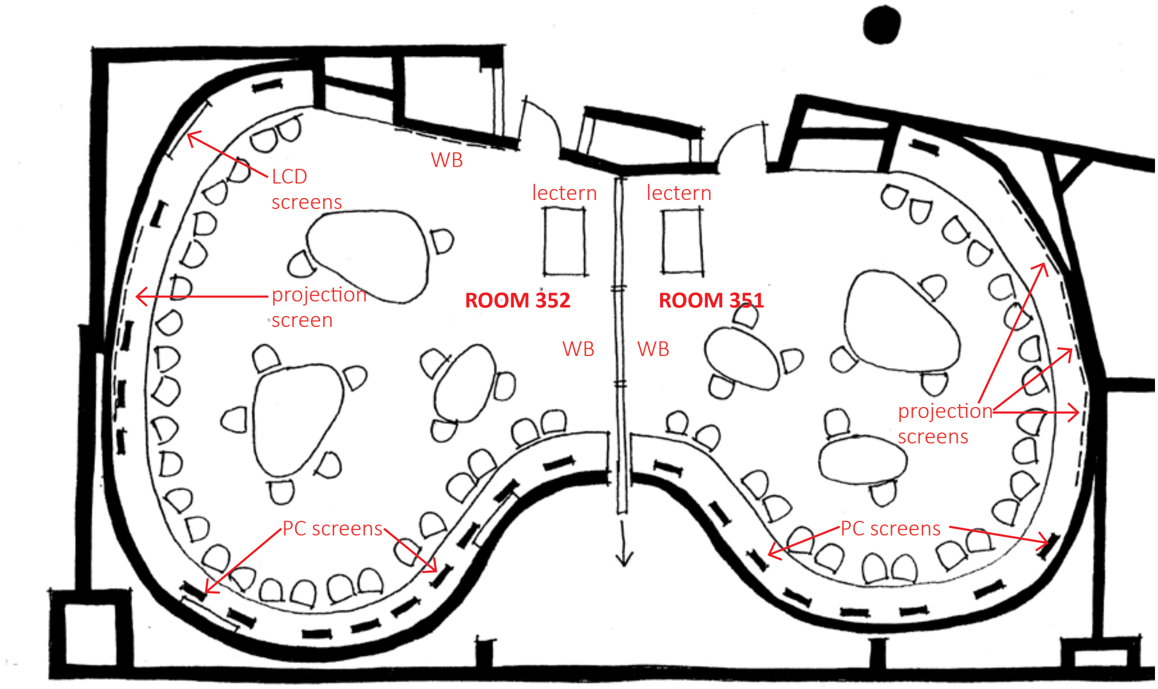


Figure 52: CTLC, Level 2, Rooms 351 & 352 Furniture Layout
Source: Author

Figure 53: CTLC, Room 352
Source: Author

Figure 54: CTLC, Room 351
Source: Author

Each space works on the premise that discussion-based activities take place in the central area and computer-based activities take place around the perimeter of the room. Therefore, the defining features of Rooms 351 are 352 are:

1. mobile tables in the centre
2. the organic perimeter bench housing fixed desktop computers
3. a cave-like ambience.

OBSERVATIONS:

- Introduction
- Pre-observations 1 & 2
- Osbervations 1 & 2
- Summary Observations 1 & 2
- Pre-observation 3
- Observation 3
- Summary Observation 3
- Pre-observation 4
- Observation 4
- Summary Observation 4
- Pre-observation 5
- Observation 5
- Summary Observation 5

PRE-OBSERVATIONS 1 & 2

6.4 OBSERVATIONS

6.4.1 Introduction

The CTLC is non-discipline specific, with all classrooms centrally booked. Five academics from a broad range of disciplines and varying year levels volunteered as research participants for this study. Each academic was interviewed about their intended approach to teaching and learning in a specific class to be conducted in the CTLC, prior to that class being observed. The following pages are organised as follows:

6.4.2 Pre-observation 1: T1 and T2—Room 352—First Year 'Systems Thinking & Practice' (two x 2-hour tutorials to be observed)

T1 and T2 team delivered the tutorial component of the subject but not the preceding lecture. Two tutorials followed on from each other, presenting the opportunity to observe the implementation of equivalent tutorials with two different cohorts of students. 'Systems Thinking & Practice' was a multidisciplinary subject for students in the Faculty of Science, meaning that the student cohort may be allocated from a range of different courses. The following class structure was anticipated to be observed:

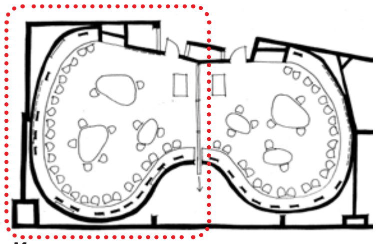
- teachers introducing concept and activity (whole-group discussion)
- students breaking into groups of up to four people for discussion
- groups taking turns to feedback their ideas to the whole class, facilitated by T1 and T2
- T1 and T2 summarising key points on the whiteboard
- T1 and T2 considering getting students to use the computers (despite previous negative experience).

"This week it will be important for us to ... start with a bit of an introduction and then break them into groups and then have those groups feed back to one another so they're all benefiting from each other." (T2)

"The smaller groups work better in the first class because I don't think they seem to interact real well. In the second class the students have formed stronger friendships with each other and they'll often just sort themselves out into a group of four or six." (T1)

T1 an T2 expressed a strong commitment to student-centred learning by instigating group-based discussion, brainstorming and problem solving. However, they were very reluctant to initiate any computer-based activities in the class as they were concerned that the location of computers at the perimeter of the room meant that students would have their backs to the teachers, which was an uncomfortable proposition for them. T1 and T2 expressed concern that they would lose control of the class. They articulated an awareness of the different characteristics of the two cohorts in the tutorials to be observed. It was of interest to observe whether the teachers treated the two cohorts differently.

OBSERVATION 1



Key

Table 9: *Observation 1 Timeline*

LEGEND

- Category 1, Teacher-directed
- Category 2, Teacher-led interactive
- Category 3, Student activity
- Category 4, Student presentation
- Start/Finish class

Teachers: T1 & T2 (Team teaching): ROOM 352

Students: 1st Year

Date: TUESDAY, WEEK 9, SEMESTER 1, 12:00 – 2:00pm

Number of students: 17

Duration of class: 2 hours

TIME	ACTIVITY	FEATURE ACTIVATED
12:00pm	– Students arrive and sit down.	
12:10	– T1 started class, introduced me and asked students to complete consent forms.	Lectern,
12:15	– Introduction to class.	Central tables
12:20	– T1 instructed class to get out 'equine case study' notes and work in groups of up to four people.	Central tables
12:22	– T2 added to introduction & instructions. – T1 utilised whiteboard to describe S.M.A.R.T. and S.A.F.E. analysis; asked class for responses.	Whiteboard, Central tables
12:24	– Students commenced activity; organised themselves into groups of 2, 3 & 4. – T1 & T2 roamed room to ensure they had all started. – Talking is audible; discussion & interaction happening. **Figure 56 & 60**	Central tables
12:27	– T1 & T2 located at lectern, in discussion.	Lectern
12:35	– T1 & T2 visited each group to check progress and in between talked to each other. – As students progressed with the activity T1 & T2 spent longer with each group. – Students discussing, making notes, utilising the pens etc. that were distributed.	Central tables
1:03	– Ten minute warning.	
1:20	– T1 calls for attention and locates herself near centre of the room. – She praises students for their efforts. – T1 responds to student activity, using whiteboard. **Figure 58**	Whiteboard, Central tables
1:25	– T1 introduces next activity, referring to assignment. She discusses referencing techniques. – She instructs students to use computers and work in the same groups. Students have been asked to search for a scientific journal.	Whiteboard, Central tables
1:30	– Students establish themselves at computers and commence activity. – T1 & T2 move from group to group to discuss progress. – T1 writes on whiteboard in preparation for further discussion. She prompts students to be able to respond to questions on the whiteboard, addressing class while they are at computers – i.e. to their backs. **Figures 57 & 59**	Fixed PCs to perimeter of room
1:50	– Students are asked to report back to class on what they learnt during that exercise (not everyone is paying attention).	Fixed PCs to perimeter of room
1:55	– T1 moved from group to group to extract responses and praised everyone for their participation and efforts. – Class ends.	Fixed PCs to perimeter of room

OBSERVATION 1

Figure 55: Observation 1 Timeline

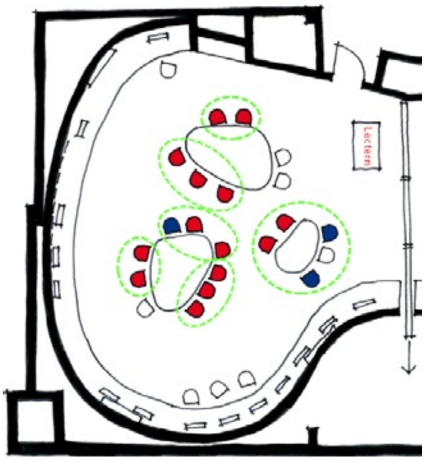


Figure 56: Observation 1, Room 352, Student Activity
Source: Author

Figure 57: Observation 1, Room 352, Student computer-based activity
Source: Author

LEGEND

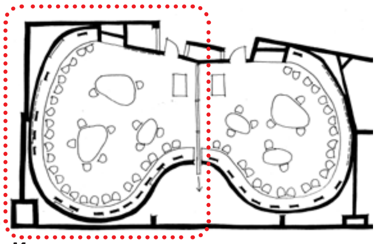
- Unoccupied seat
- Female occupant
- Male occupant
- Self-organised clusters of student groups

Figure 58: Observation 1, Room 352, Teacher-directed
Source: Author

Figure 59: Observation 1, Room 352, Student computer-based activity
Source: Author

Figure 60: Observation 1, Room 352, Student Activity
Source: Author

OBSERVATION 2



Key

LEGEND

- Category 1, Teacher-directed
- Category 2, Teacher-led interactive
- Category 3, Student activity
- Category 4, Student presentation
- Start/Finish class

Table 10: *Observation 2 Timeline*

Teachers: T1 & T2 (Team teaching): ROOM 352

Students: 1st Year

Date: TUESDAY, WEEK 9, SEMESTER 1, 2:00- 4:00pm

(NB. Repeat of Class/Ob 1)

Number of students: 21

Duration of class: 2 hours

TIME	ACTIVITY	FEATURE ACTIVATED
2:00pm	– Students arrive and sit down.	
2:05pm	– T2 introduced topic for today and requested that students complete consent forms.	Lectern, Central tables
2:15pm	– Students directed to commence activity and organised themselves into groups. – Students are not directed specifically regarding group numbers, but organise themselves into groups of 2s and 3s. **Figures 62 & 66**.	Central tables
2:50pm	– T2 advised next activity would commence in 10-15 mins. and to make sure students attempted the S.A.F.E. analysis.	Whiteboard, Central tables
3:15pm	– T2 called activity to a close. Introduced next activity. **Figure 64**	Whiteboard, Central tables
3:20pm	– Instructed students to hop onto computers. **Figures 63 & 65**	Fixed PCs to perimeter of room
3:50pm	– T2 called students to report back, verifying that everyone had completed tasks.	Fixed PCs to perimeter of room
4:00pm	– Class ends.	

OBSERVATION 2

Figure 61: Observation 2 Timeline

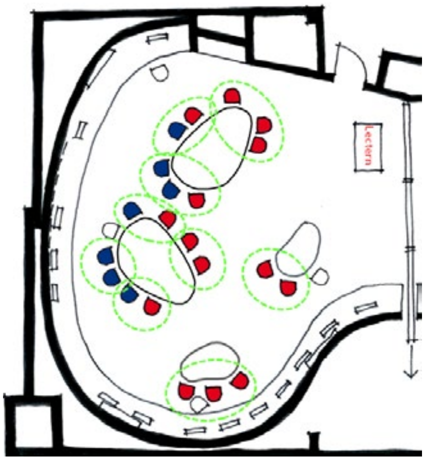


Figure 62: Observation 2, Room 352, Student Activity
Source: Author

Figure 63: Observation 2, Room 352, Student computer-based activity
Source: Author

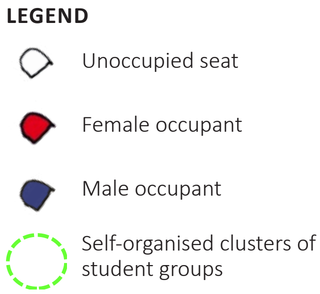


Figure 64: Observation 2, Room 352, Teacher-led interactive
Source: Author

Figure 65: Observation 2, Room 352, Student computer-based activity
Source: Author

Figure 66: Observation 2, Room 352, Student Activity
Source: Author

6.4.3 Summary Observations 1 and 2

The first class (Observation 1) was implemented more or less as described by T1 and T2 in the interview preceding the observation. However, despite both teachers expressing discomfort about instigating computer-based activities in class, as 'you might as well be teaching to a brick wall', they did ask students to work in groups on the computers for a specific activity. They did not 'lose control' of the class as they had feared and when most students had completed the task, T1 and T2 led an interactive discussion with the students about what they had learned during the computer exercise. The feedback from T1 and T2 was that this was the most interactive class they had experienced with this cohort, who had previously been described by T1 as 'sitting there expecting to be lectured at ... everyone just gives you a blank look'.

The second class also proceeded as anticipated, with the cohort being noticeably noisier. As with the first class, the second class was asked to undertake a computer-based activity. Although T1 and T2 were concerned that they would 'lose control' of the students while they were working on the computers, as the computer screens face inwards towards the room, this enabled the teachers to easily view what students were doing. T1 and T2 appeared to interact with students on the computers just as readily as if they were sitting around the tables. They had expressed their discomfort with the idea of students having their back to them, yet there was no sign that this was a negative experience for the students.

While T1 and T2 did not utilise all features of the room, students were evidently engaging in group discussion, brainstorming and problem solving around both large and small mobile tables; when it was appropriate they moved to the perimeter of the room to access the computers. The groups moved around the room according to the activities set by the teachers; the teachers were able to focus the students' attention for short periods to introduce tasks and provide feedback before moving on to the next task.

	% Class Time Observation 1	Observation 2
Category 1, Teacher-directed	**13%**	**4%**
Category 2, Teacher-led interactive	**4%**	**8%**
Category 3, Student activity	**67%**	**75%**
Category 4, Student presentation	**8%**	**8%**
Start/Finish class	**8%**	**4%**

Figure 67: Percentage of teaching & learning categories during Observations 1 & 2

PRE-OBSERVATION 3

6.4.4 Pre-observation 3: T3—Room 351—Fifth Year 'Veterinary Public Health' (2 hours)

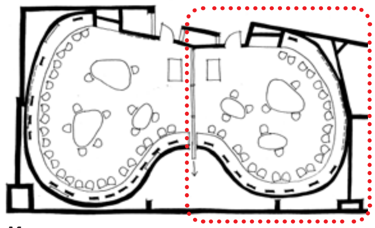
The following class structure was anticipated for the fifth year subject:

- T3 would explain the objective of the class
- students would work in groups of three on one of two proprietary computer-based exercises
- students would work on computers in the classroom to undertake this activity
- student groups would present their work to the whole class at the end
- T3 would facilitate presentations
- T3 would be available to assist groups during class.

The computer activities are pre-set. So the actual cases that they are involved in are already there on the computers in the CTLC, and all they need to do is to open that up and they then go through it. I am there to help, and so it's designed so that they can work independently and collaboratively within the groups of three or four with me to help if they get stuck. (T3)

T3 expressed a strong disposition for student-centred learning, indicating that she expected students would work on allocated problems without a lot of intervention from her. T3 would facilitate the presentation component to ensure all students had understood key concepts regardless of which problem they worked on during the class.

OBSERVATION 3



Key

LEGEND

- Category 1, Teacher-directed
- Category 2, Teacher-led interactive
- Category 3, Student activity
- Category 4, Student presentation
- Start/Finish class

Table 11: *Observation 3 Timeline*

Teachers: T3 ROOM 351

Students: 5th Year

Date: THURSDAY, WEEK 9, SEMESTER 1, 2:00- 4:00pm

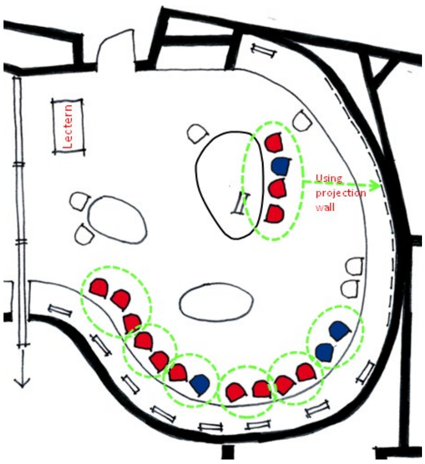
Number of students: 17

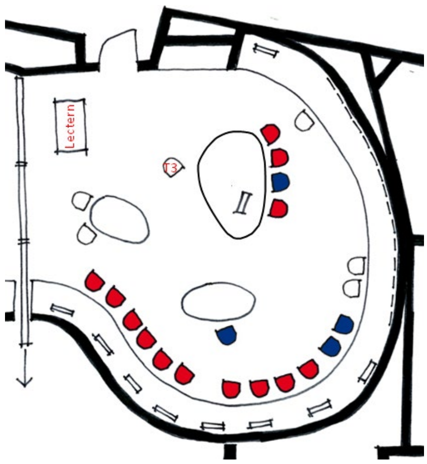
Duration of class: 2 hours

TIME	ACTIVITY	FEATURE ACTIVATED
2:00pm	– Slight delay waiting for students to vacate room.	
2:05pm	– Students arrive and take seats. T3 introduced the researcher to the class and the research project was explained. T3 then introduced & divided tasks. T3 requested students to work in pairs. – T3 estimated it would take students 1 hr 15 minutes to complete task.	Seats to perimeter of room. Lectern.
2:10pm	– Students organised themselves, established computer connectivity and commenced problems. T3 spent some time writing on whiteboard located on sliding partition. T3 then moved from group to group, standing behind pairs to observe their progress. **Figures 69, 71 & 72**.	Seats & PCs to perimeter of room. One group at a central table.
3:15pm	– T3 called students together. She provided a brief outline of expectation to learn from each other. Each group took turns to report back to the class. As students presented, T3 responded and extended their answers. **Figures 70 & 73.**	Lectern Seats to perimeter of room.
3:25pm	– T3 interrupted presentation to refer class to the whiteboard (prepared earlier) and asked questions to students.	Whiteboard Seats to perimeter of room.
3:30pm	– Back to student presentations.	Seats to perimeter of room.
3:35pm	– T3 completed discussion on first round of presentations, and then commenced second series of presentations. – One group utilised the projection wall which enabled other groups to refer to the task and discuss communally. – One student came up to the whiteboard to demonstrate understanding of the topic. – T3 was very interactive, helping students validate their responses, elaborating where necessary. She directed particular students to respond to particular parts of each task.	Seats to perimeter of room. Projection wall. Whiteboard
4:00pm	– Class ends.	

OBSERVATION 3

Figure 68: Observation 3 Timeline





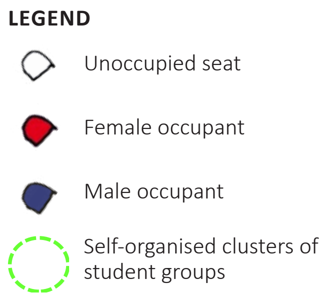


Figure 69: Observation 3, Room 351, Student Activity
Source: Author

Figure 70: Observation 3, Room 351, Student presentation
Source: Author

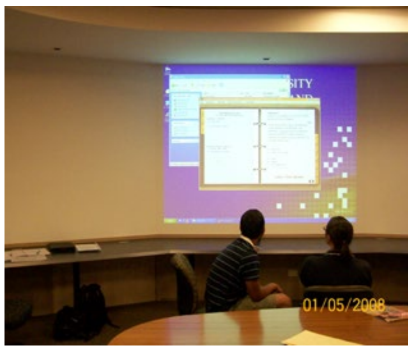


Figure 71: Observation 3, Room 351, Student Activity
Source: Author

Figure 72: Observation 3, Room 351, Students using projector instead of computer
Source: Author

Figure 73: Observation 3, Room 351, Student presentation
Source: Author

OBSERVATION 3

6.4.5 Summary Observation 3

This cohort of fifth year students displayed a maturity that was reflected in their approach to the tasks set by the teacher. T3 provided a brief introduction to the class activities, which were set problems to be accessed online. The students quickly organised themselves into groups of three and set about working through one of the set problems on the fixed computers. There was a distinct informality in the way students sat around the room, engaging in discussion with each other and with T3.

The students went about their class activities diligently and effectively. T3 was a guiding force in the room but neither imposed her presence nor neglected the students. The last 45 minutes were dedicated to student presentations, with groups reporting back on their approach to the assigned problem. T3 briefly interjected part way through to provide feedback and contextualise a student's response before the student presentations resumed. Only 8% of class time was teacher led or teacher directed; 87% was dedicated to student activity or student presentation (refer Figure 74). This appeared to be symptomatic of the year level, as well as the teacher's approach. T3 confirmed, 'I treat these 5th year students with a different attitude to what I would with my 3rd years, in that I think they are six months away from graduation and they should be a bit more mature and be involved' (T3).

The behaviour and attitude of fifth year students was noticeably different from that of T1 and T2's first year students. The first year students were teacher focused and used the resources of the learning environment in response to the teacher's instruction. The fifth year students were less focused on the teacher, working interdependently and engaging with the teacher as their resource. In first year, the learning environment was the teacher's resource while in fifth year the learning environment was increasingly the student's resource.

	% Class Time Observation 3
Category 1, Teacher-directed	**4%**
Category 2, Teacher-led interactive	**4%**
Category 3, Student activity	**54%**
Category 4, Student presentation	**33%**
Start/Finish class	**4%**

Figure 74: Percentage of teaching & learning categories during Observation 3.

PRE-OBSERVATION 4

6.4.6 Pre-observation 4: T4—Room 241—First Year 'Communication for Therapy' (90 minutes)

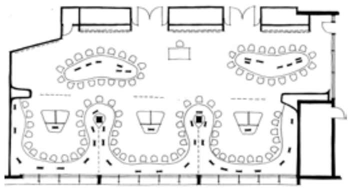
T4 conducted a lecture immediately prior to the tutorial. This class was one of two tutorials conducted for the same subject in Room 241. Only one observation would be undertaken by the author. The following class structure was anticipated:

- the room would be in seminar mode
- T4 would introduce the tutorial activity
- students would break into groups of three to five for a computer-based activity
- T4 would move from group to group, verifying they knew what they are doing and providing feedback
- student groups would report back to each other at the end of class
- T4 would summarise student reports on the whiteboard.

In that space I use different teaching approaches. Although my teaching approach with 'communication' is based on experiential learning. And so in that space we do some small group work, we do some role playing and some practical tasks, web-searching, which is what we're going to be doing tomorrow. (T4)

Teacher T4 expressed a strong disposition for student-centred learning by indicating that students would spend a great deal of time in groups undertaking a collaborative computer-based activity. It was anticipated that T4 would provide guidance to the students and facilitate a presentation process for sharing student results.

OBSERVATION 4



Key

LEGEND

Category 1, Teacher-directed
Category 2, Teacher-led interactive
Category 3, Student activity
Category 4, Student presentation
Start/Finish class

Table 12: *Observation 4 Timeline*

Teachers: T4 ROOM 241

Students: 1st Year

Date: THURSDAY, WEEK 9, SEMESTER 1, 12:30- 2:00pm

Number of students: 47

Duration of class: 90 mins.

TIME	ACTIVITY	FEATURE ACTIVATED
12:30pm	– Students arrive and take seats.	
12:35pm	– T4 introduced class and organises pairing for future activity. – T4 introduced the researcher to the class and the research project was explained. – T4 locates at the podium and relates lecture content to tutorial topic. She projected images onto two walls. – T4 is generally in didactic mode, but at one point asked for a student response.	Blinds are down. The room is in 'seminar mode'. T4 at lectern. Pods 1, 2, 3 & 5 are occupied.
1:00pm	– T4 introduced task. She asked students to work either in small groups or individually if preferred. T4 advised there will be questions on exam about this topic.	
1:05pm	– Students commenced activity, organising themselves into groups. – Four students left the room (possibly not from T4's class). **Figures 76 & 77**.	Fixed PCs
1:25pm	– T4 instructed students to access a computer and look at a particular website. – T4 moved from group to group, sitting with each group to discuss topic.	
1:50pm	– T4 called class together, everyone focusing on T4 at podium. – T4 asked for voluntary student responses. – A student who volunteered was asked by T4 to come to the podium so she could be heard over the microphone.	T4 at lectern. Pods 1, 2, 3 & 5 are occupied.
1:55pm	– Class ends.	The room remained in 'seminar mode' throughout class.

OBSERVATION 4

Figure 75: Observation 4 Timeline

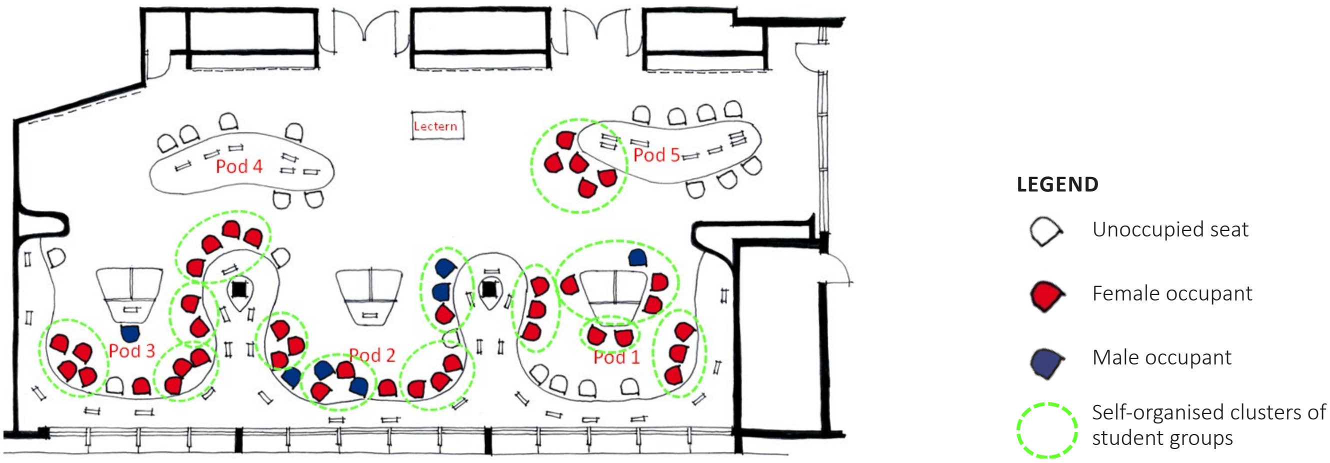


Figure 76: Observation 4, Room 241,
Student Activity
Source: Author

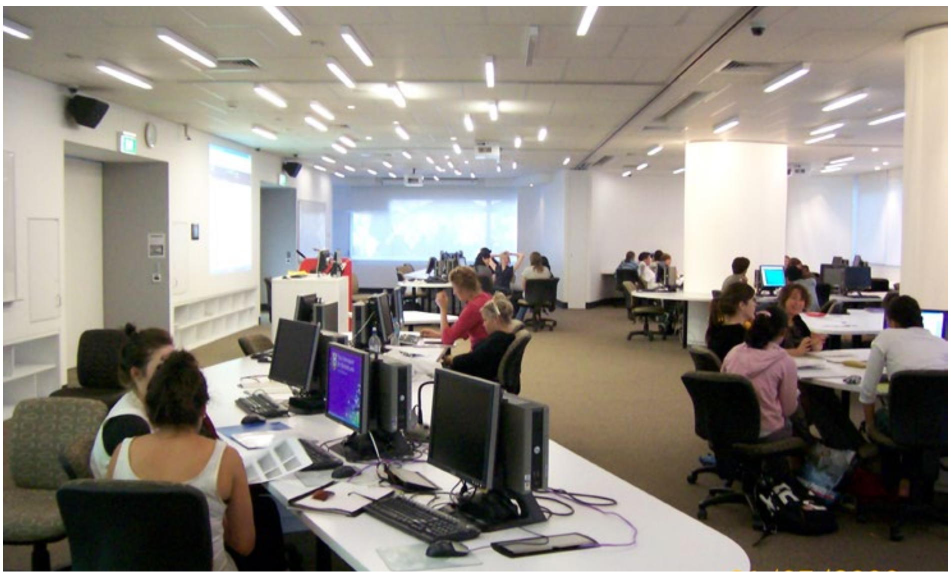


Figure 77: Observation 4, Room 241,
Student Activity
Source: Author

OBSERVATION 4

6.4.7 Summary Observation 4

T4 was teaching a tutorial in Room 241 for a first year subject titled 'Communication for Therapy'. T4 commenced the class in seminar mode, summarising key points from the preceding lecture that she had conducted. T4 utilised two synchronous wall projections; students were sitting on chairs mostly swivelled towards the teacher. After 30 minutes T4 instructed students to undertake a task, requesting them to organise themselves into groups. While students were working on the activity, T4 moved around the room, often sitting with a group to discuss the task or answer questions. There were approximately 16 groupings of between two and five people, which made it difficult for T4 to have an extended discussion with every group. T4 later described that she dealt with this issue by 'watching out for groups that seem to be struggling [and] joining those groups'.

The room remained in seminar mode throughout the whole class. T4 explained that she did utilise 'pod mode' for one particular tutorial on spirituality, where pods 1, 2 and 3 were used as private spaces for sensitive discussions, but that occurred at another stage of semester. Otherwise she kept the room in 'seminar mode' so that students could 'spread out wherever they feel comfortable'. T4 expressed that while she does not use the full spectrum of the facility, 'having this space makes a great difference'.

While T4 anticipated a plenary group feedback session, time ran out. She enticed one student to come to the podium to provide some key points from her group's response, but this appeared to be quite an uncomfortable experience for the student. T4 concluded the class with an outline of next week's lecture. While over one-third of the class was conducted in teacher-directed mode, the students were provided generous time to undertake the group activity (refer Figure 78). Although T4 did not initiate a comprehensive whole-class feedback session towards the end of the tutorial, she expressed she was satisfied that the cohort had achieved the ILOs for that class.

OBSERVATION 4

	% Class Time Observation 4
Category 1, Teacher-directed	**33%**
Category 2, Teacher-led interactive	**6%**
Category 3, Student activity	**50%**
Category 4, Student presentation	**0%**
Start/Finish class	**11%**

Figure 78: Percentage of teaching & learning categories during Observation 4.

Figure 79: Observation 4, Room 241, Teacher-directed
Source: Author

Figure 80: Observation 4, Room 241, Teacher-directed
Source: Author

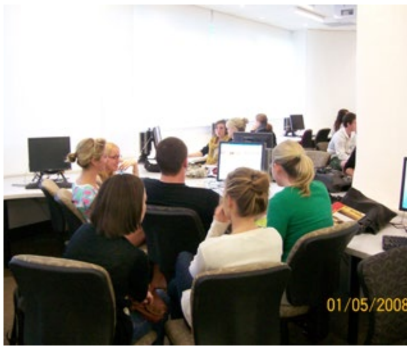


Figure 81: Observation 4, Room 241, Student activity
Source: Author

Figure 82: Observation 4, Room 241, Student activity
Source: Author

Figure 83: Observation 4, Room 241, Student activity
Source: Author

Figure 84: Observation 4, Room 241, Student activity
Source: Author

PRE-OBSERVATION 5

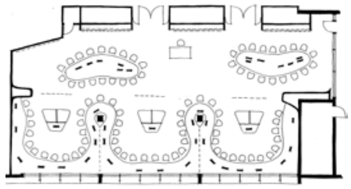
6.4.8 Pre-observation 5: T5—Room 241—Third Year 'Arthropods and Human Health'

The tutorials were supported each week by a lecture, conducted elsewhere by T5. 'Arthropods and Human Health' required students to undertake a PBL assignment for the duration of the semester. The tutorial component was an opportunity for students to work on their PBL assignments. It was revealed that T5 did not normally attend most tutorials, expecting students to use the time effectively to access resources in an environment that enabled groups to work together:

> *In this form of PBL learning, I do not actually attend these sessions except the very first one. We form the groups and they are assigned problems, but later on it's just a very informal for students to come and work as a group ... it's a timetabled event … there's no lecturer, no tutor, no one present.* (T5)

According to T5, he demonstrated his commitment to student-centred learning by not actually being present during the tutorial. He expected students to develop their understanding of the topic by learning from each other. This may have been a positive endeavour but it was unclear whether this tutorial practice was sanctioned by the university. T5 expressed that students were able to ask him questions relating to their PBL assignment, either after the lecture or by appointment in his office. T5 would accompany the author to Room 241 to show how the students were working. It was of interest to observe how many students were actually present in the classroom during the timetabled tutorial, given they would not be expecting T5 to be there.

OBSERVATION 5



Key

Table 13: *Observation 5 Timeline*

LEGEND

- Category 1, Teacher-directed
- Category 2, Teacher-led interactive
- Category 3, Student activity
- Category 4, Student presentation
- Start/Finish class

Teachers: T5, ROOM 241

Students: 3rd Year

Date: FRIDAY, WEEK 9, SEMESTER 1, 10:00- 11:00am

Number of students: 23 (50 expected)

Duration of class: 90 mins.

TIME	ACTIVITY	FEATURE ACTIVATED
10:00am	– Students are expected to attend room 241 between 10 – 11am to undertake group PBL activities. The room is timetabled for this class at this time, but is not supervised by T5.	The room is in 'individual mode', the blinds are up. Pods 1, 2 & 4 are occupied. The room configuration did not change during the observation.
	– There are four distinct groups working together. They are: - discussing together - accessing computers in pairs & small groups - accessing computers as individuals - discussing as a group – breaking away to do something individual on the computer – going back to the group.	
	– T5 spoke to some of the groups to check their progress.	
10:30am	– T5 left.	
10:45am	– Most groups finished their meetings and left by 10:45am. – Some students stayed to work on computers on their own.	

OBSERVATION 5

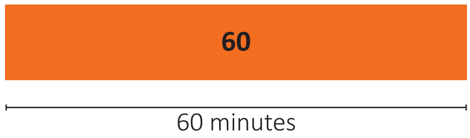


Figure 85: Observation 5 Timeline

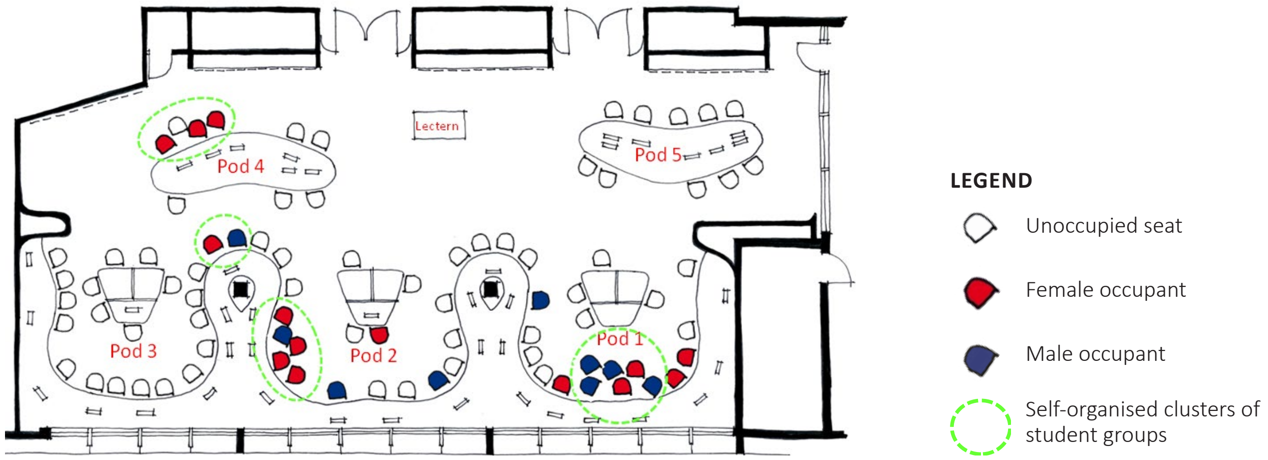


Figure 86: Observation 5, Room 241,
Student Activity
Source: Author

	% Class Time Observation 5
Category 1, Teacher-directed	**0%**
Category 2, Teacher-led interactive	**0%**
Category 3, Student activity	**100%**
Category 4, Student presentation	**0%**
Start/Finish class	**0%**

Figure 87: Percentage of teaching & learning categories during Observation 5.

OBSERVATION 5

6.4.9 Summary Observation 5

Teacher T5 coordinated a third year science subject titled ‘Arthropods and Human Health’. It was organised as a series of lectures, PBL and laboratory activities. The program of lectures and PBL activities occurred at the same time each week, with lectures taking place in a lecture theatre for designated weeks of the semester, and PBL activities taking place in the CTLC Room 241 during the other weeks.

The unusual aspect of T5’s practice was that, apart from the first PBL class whereby he introduced two pre-set problems for students to choose from, he did not attend class to supervise students during their PBL activities. Teacher T5 timetabled Room 241 for his students because ‘it’s more comfortable talking and discussing as a group and also they have access to the internet’. He provided a process for seeking assistance on PBL problems from various tutors and then left students to motivate and organise themselves. This appeared to be an attempt to decrease dependence on the teacher and increase interdependence among student groups.

The students were afforded the freedom to use Room 241 at the assigned time or to utilise other facilities around the campus that also supported group work, including library and cafe spaces. Knowing that T5 did not plan to be there, it was surprising that almost half the class was present during the ad-hoc visit T5 made with the author. The class was set up in ‘individual mode’; that is, blinds were up and all lights were on. Students were clustered around computers and were evidently working in groups. While students could have been undertaking analogue activities (such as discussion, reporting, brainstorming. etc.) in other spaces around campus, the CTLC is one of the few facilities that enable groups of students to work around a single computer. The generosity of space between desktop computers, arising from the strategy of having one computer per three students, enabled a group of students to undertake multiple activities concurrently, with the convenience of computer-based resources being available to them.

DISCUSSION

6.5 DISCUSSION

6.5.1 Design Features and Student-Centred Learning

The large and small classrooms in the CTLC each exhibited unique features and attributes that enabled student-centred learning, providing two distinctly different collaborative learning experiences. Further, the features of the CTLC classrooms presented a dramatically different collaborative learning experience than could possibly be instigated in any traditional learning space.

Seminar rooms and general teaching spaces often enable small groups to collaborate on analogue activities, but do not enable simultaneous computer access. Computer laboratories provide access to networked resources but do not provide the amenity to have groups of students collaborating around a computer. The CTLC classrooms provided the amenity to do both: to have small groups of students collaborating simultaneously while accessing a computer. The observed episodes demonstrated that a high degree of collaborative learning was taking place within the CTLC.

Several small groups of up to five students were observed engaging in discussion, mapping, problem solving and computer-based activities. The high ratio of one computer per three people had clearly enabled collaborative computer-based activities. The spaciousness of the room settings enabled effective small group activities not afforded in the majority of general teaching spaces.

Therefore, the fundamental features of the CTLC classrooms that set them apart from other traditional teaching spaces were:

1. the technology system that provided four distinct teaching and learning modes, in particular 'pod mode' and 'feedback mode' (most prevalent in the large classrooms)
2. the ratio of one computer per three students
3. the dramatic ambience of the classrooms.

6.5.2 Pod Mode

What genuinely set Room 241 apart from any other classroom of its scale was the theatrics of 'pod mode' and the technological capacity of 'feedback mode'. Unfortunately, the participating teachers did not utilise these features, although teacher T4 confirmed she had used 'pod mode' simply to subdivide the space in one of her classes.

Evaluations have been undertaken by the University of Queensland on the CTLC, as reported by Andrews and Powell (2009); however there remains a lack of published evidence regarding user feedback on aspects of Room 241, particularly when operated in ‘pod mode’. Andrews and Powell report that 33% of staff survey responses indicated the ‘ability to project individual pod materials onto the main screen when not in pod mode’ was problematic, prompting future improvement actions to: a) utilise LCD screens rather than data projectors in future; and b) to allow the use of pod features in ‘individual mode’. While Andrews and Powell’s report apparently did not investigate how teachers used ‘pod mode’, this finding begins to suggest that staff were experiencing technological constraints.

While there have been many favourable comments published about features of the CTLC (Andrews & Powell, 2009; Jamieson, 2005; Radcliffe, Wilson, Powell & Tibbetts, 2009), little commentary has focused specifically on how pedagogically effective ‘pod mode’ is in the large classrooms. The absence of such evidence and the researcher’s anecdotal experience of the facility created the perception that perhaps this experimental technology has not been as successful as other aspects of the CTLC. Further, even though teachers were required to undertake specific training to learn the features and technological capacity of the CTLC, ‘observations indicate that much teaching still takes traditional approaches and does not attempt to utilise the spaces for any kind of collaboration in the way that it is intended’ (Andrews & Powell, 2009, p. 49). It appears that building an exemplary teaching and learning facility founded upon best practice pedagogy does not automatically result in teachers using the facility in ways that were anticipated during design. This is not to suggest that collaborative learning was not happening in the CTLC—clearly it was. However the concept of ‘pod mode’ did not appear to have been well supported by teachers.

Why might this be the case? One fundamental constraint related to the size of groups expected to collaborate in ‘pod mode’. Each pod had a capacity of up to 18 students. Each pod had one data projector and approximately six desktop computers. While it as feasible for groups of three people to cluster around a computer, it was problematic to consider how a group of 18 might share use of the data projector. This size of group was at odds with the literature on collaborative learning, which recommends effective group sizes of three to six people, extending to up to eight in some contexts (Bruffee, 1993; Jacques, 2000; Race, 2000). Pod mode created spaces to contain up to 18 people, who could conceivably work as six groups of three around the desktop computers. However, the difficulty lay in devising activities that required harmonious cooperation and collaboration for 18 people. The LED expressed discomfort about the size of the pods, stating that 'the numbers were all wrong; the size of the group was too large for the engagement that you'd really want'. He said:

> *At some point in time one of the critical functions will be that you can bring the entire pod of students together and make a common reference to the screen that the pod was working to. Now it might be that the material came from the teacher or it might also be that the material came from somebody in the pod. The only problem was that the control of the device linking the computer to the projector rested at the central table for each pod ... and that meant there is a disempowerment of the other people in the circle in each of the pods ... I had real problems with all that.* (LED)

While 'pod mode' was novel, the indications were that the group size of 18 was problematic. This was a crucial lesson to be learned and shared with the higher education community. Published papers (Andrews & Powell, 2009; Radcliffe et al., 2009) stop short of criticising this feature; however the issue was acknowledged by the architect and the AVM in this study:

> *The way it was described they were set different projects so each of the groups could work on their project. But whether they were working together as 20, I doubt if that was actually possible because I think 20, it's too many people.* (Architect)

> *I think group size is important, but I think what the room has sparked has been even more important. So yes, we've discovered that 18 or 20 is too large, except that some very interesting things can be done with groups of 18 or 20, but none have been thought of.* (AVM)

It was anticipated by the AVM that if 'pod mode' and 'feedback mode' were made available to smaller groups of students, then these features would be more highly utilised. This was tested in the second iteration of the CTLC at the University of Queensland's Gatton campus where group size was reduced to a maximum of nine people. Andrews and Powell report that aspects of the Gatton campus facility positively identified by students included 'pods supportive of group work' and 'being able to share work on the big screen, allowing input from everyone' (2009, p. 50). This supports the notion that the technological capability of 'pod mode' and 'feedback mode' was valuable in the teaching and learning context, but that its effectiveness was intrinsically linked to the size of the student group.

6.5.3 Ratio of One Computer Per Three Students

The ratio of computers to students was a fundamental characteristic of the CTLC that set the classrooms apart from traditional teaching spaces. Each computer was located with a generous amount of space around it, enabling a group of three students to comfortably congregate around. Essentially, one person was required to operate the computer keyboard, but the keyboard could conceivably be accessed by either of the three students.

This was a distinctly different experience from computer laboratories and libraries; in such facilities universities are compelled to respond to student demand for access to computers on campus, by housing as many computers as physically possible in a designated space. This usually results in computers being located in close proximity to each other, rendering it impossible for more than one student to comfortably sit at a computer. These settings promulgate a ratio of one computer per student, thereby diminishing opportunities for collaborative computer-based activities to take place.

It was unclear on what basis the specific ratio of one computer per three students was determined. With little precedence from similar learning spaces or settings, the decision was essentially intuitive. As the design of the large classrooms developed the initial response by the architect was to fit as many students as was physically possible into the space. This resulted in a potential capacity of up to 120 students. The LED and AVM instinctively knew this was counterintuitive to collaborative learning and set about removing chairs and computers from the plan until they felt the space would work. The LED explained:

> *I whittled it down by just showing people there were too many people in the room. And so we basically pulled chairs out of the spaces until we found it worked. I remember going through the process of plucking chairs out and also reducing the number of computers, because what I was intending to do in that room was not create, by default, an IT laboratory.* (LED)

Observation 4, undertaken in Room 241, involved students collaborating at computers on a computer-based activity. T4 did not specify that students should work in groups of three, suggesting only that students work in small groups, or individually if preferred. While most students did appear to be working in groups of two, three and sometimes four, there was one instance of six students grouped around a computer. It was evident that this was an awkward setting for all students to equitably contribute to the activity (see Figure 88).

6.5.4 Dramatic Ambience of the Classrooms

The ambience of both large and small classrooms was likely to affect the student learning experience in two ways. First, it was immediately apparent that both classrooms were not like any other typically institutional classroom environment. The unique furniture settings, high-quality finishes and contrasting ambient conditions signalled to teachers and students that these environments were designed more for interaction and collaboration than for sitting and listening.

Second, and particular to the large classrooms, changes in the operational modes of the room generated a dramatic change in ambience, from light and bright, to dark and focused or compartmentalised with screens for visual separation. Apart from the distinct shift in function that accompanied each change of mode, the drama of the change was anticipated by the architect to shift students' awareness of the changing activities and focus required by the student.

The architect described their deliberate attempt to 'create spaces that could shift people's experience and engage with the learning process'. This accords with Marton and Booth's concept of 'awareness', whereby 'a particular way of experiencing something'—for example the classroom environment—'reflects a simultaneous awareness of particular aspects of the phenomenon' (1997, p. 107). In this sense the environment comprised furniture, visible equipment, lighting conditions and finishes.

Changes to the environment such as variable lighting conditions were intended to create an awareness of the changing experience to the student, rendering an altered level of consciousness of the purpose of the environment. As the shift in consciousness occurred, the student's behavioural expectations would also change. When the room darkened, highlighting the walls of data projection, the students would

Figure 88: Large group of students around a single computer, Room 241
Source: author

understand that they needed to focus on the data projection for a presentational experience. When screens dropped down from the ceiling to subdivide the room, the students would understand that they needed to be prepared to interact and collaborate with collocated peers and not be distracted by the adjacent group.

6.5.5 Summary

Overall, the design features appear to support a wide variety of teaching practices, student cohorts and disciplines, as observed in the CTLC classrooms. Among the observed encounters, student activity formed the primary teaching and learning category in each episode (50–100%), with only episode 4 demonstrating a relatively high proportion of teacher-directed practice (33%), refer Figures 89 and 90. This demonstrates the flexibility of teaching and learning situations made possible in the small and large CTLC classrooms.

	% Class Time				
	Ob 1	**Ob 2**	**Ob 3**	**Ob 4**	**Ob 5**
Category 1, Teacher-directed	**13%**	**4%**	**4%**	**33%**	**0%**
Category 2, Teacher-led interactive	**4%**	**8%**	**4%**	**6%**	**0%**
Category 3, Student activity	**67%**	**75%**	**54%**	**50%**	**100%**
Category 4, Student presentation	**8%**	**8%**	**33%**	**0%**	**0%**
Start/Finish class	**8%**	**4%**	**4%**	**11%**	**0%**

Figure 89: Comparison of Teaching & Learning categories across CTLC observations

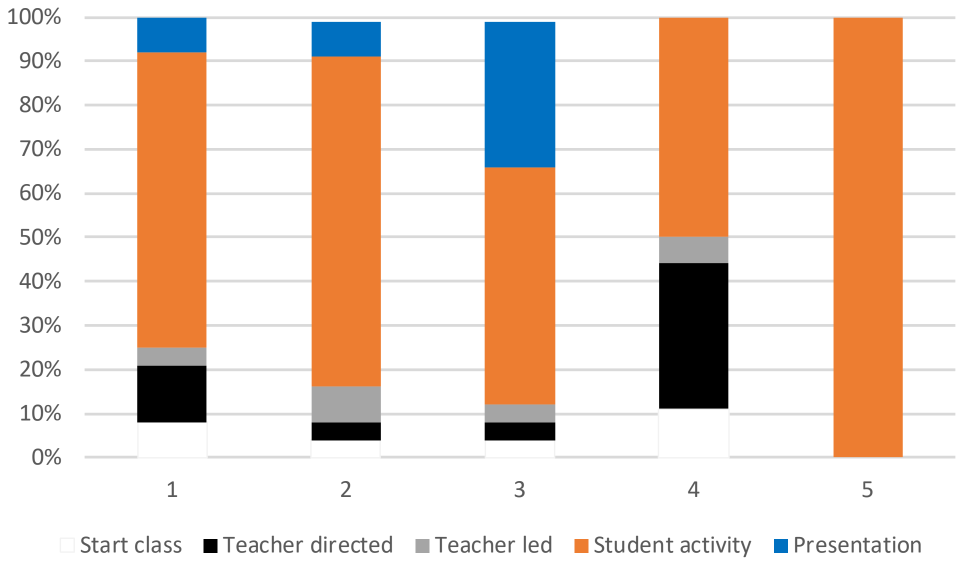


Figure 90: Graphical Comparison of Teaching & Learning categories in the CTLC

6.6 ALIGNMENT WITH THE EFFECTIVE TEACHING AND LEARNING FRAMEWORK

How do these observations and insights align with the Effective Teaching and Learning Framework? Has the CTLC enabled effective teaching and learning?

The classes observed in both the small and large NGLEs in the CTLC demonstrated how teachers can engage with students as a whole class, in small groups and with individual students (Element 1). Teachers in each class were able to move around the room and access students easily. Students were able to access the desk top computers in each classroom, sharing one computer between two or three students, although were not observed accessing whiteboards. Only the teachers were observed using the whiteboards in Rooms 351 and 352. However, there was no apparent reason why students could not use the whiteboards at another time. Teachers were observed having engaging discussions with individuals and small groups, giving the impression that meaningful relationships were developing with students.

Students in all observations were viewed working in small groups, interacting at a personal or intimate distance (Element 2). In the large classroom, room 241, students transitioned from listening to the teacher (T4) address the whole class (social distance) to working in small groups (personal distance) without having to move. The desktop computers were evenly dispersed along desks around the whole room and conveniently located for small groups of students to access. In rooms 351 and 352, groups moved from tables located in the centre of the room to desktop computers around the perimeter. Interactions between students appeared to be focused and meaningful, with considerable discussion and activity (intimate distance). It is possible to conclude that knowledge was being constructed in a social context.

The large and small classrooms evidently enabled students to manipulate the environment and work at their own pace (Element 3). This was most visible in the smaller classrooms where students moved their chairs from the central tables (where discussion had taken place) to the desktop computers (where specific tasks took place). Students worked at their own pace to complete the designated tasks but came together as a whole class to discuss their responses. Despite T1 and T2’s concerns that they might lose control over the class by facilitating the computer-based tasks (Observations 1 & 2) they expressed their delight that student interaction and engagement noticeably increased during those classes.

While collaborative learning was clearly visible in every observed class (Element 4) and students were observed engaging in different types of content through the desktop computers, there was little opportunity for students to capture content created (primarily by the teachers) during class. This was probably symptomatic of the available technologies available to students at the time (for example, before smart phones with cameras). However, it was possible for content sharing to occur via the available online platforms.

Students were observed collaborating and working at their own pace (Element 5), but in most instances they were undertaking the same task as others in their class. The exception to this occurred in Observation 5 where student groups (and individuals) were viewed working on semester-long group-based PBL projects. Teacher T5 described how students developed their own project responses to the PBL framework provided by T5, thereby resulting in all student groups working on different types of content at the same time.

Teachers T1, T2 & T3 were each observed reacting and adapting their classes within the smaller NGLES, Rooms 351 and 352, by stopping what students were doing to discuss a particular concept that students appeared to be struggling with. This indicated their awareness of gaps in student knowledge, to which the teachers spent additional time discussing important concepts and ensuring that the students understood those concepts. The smaller classrooms enabled teachers to react as they could see and hear students to detect their level of knowledge. This was less evident in Room 241, where one teacher was facilitating a class of 47 students. It was logistically more difficult for the teacher to speak or listen to every group and gauge their level of understanding. Increasing the number of support teachers in the large classroom would have helped manage this issue.

Teachers were observed discussing and providing feedback to students in each observed episode (Element 6). This was evidently more effective in the small classrooms with smaller numbers of students. The teacher could easily and equitably access all students and engage in meaningful discussion. Teacher T4 was able to move easily around the room to provide feedback to students but appeared unable to speak to all groups due to the number of students and limited time. In this instance the design of the room did not limit the teacher's ability to provide feedback. The ability to provide feedback was impacted by the student to teacher ratio coupled with the 1.5 hour timetabled class, which simply did not give enough time for the teacher to interact with all groups.

6.7 CONCLUSION

The CTLC has piqued the interest of many universities in Australia and elsewhere and provides a pioneering example of what is involved in creating a facility for collaborative teaching and learning. The University of Queensland has shared the positive and negative aspects of the facility, so that the higher education community can learn from its successes and mistakes.

The community has learned the importance of creating a clear educational vision for a NGLE, a vision that encapsulates a narrative of student-centred learning. Critically, this involves understanding how many people create an effective group, the range of activities that may be undertaken and how technology may or may not be utilised to enhance the learning experience. We have learned from the CTLC that a group size of 18 people is too large to generate a truly effective collaborative learning experience.

The state-of-the-art technology affords a range of learning activities not possible in traditional learning environments, but simultaneously intimidates all but the most technologically savvy and experienced teachers. Observations of teaching and learning episodes, in both the small and large classrooms, revealed a reluctance on the part of many academics to fully embrace the technological capacity of the CTLC. This is a reminder that technology does not have to be activated for collaborative learning to be implemented. However, it also indicates that teachers may require more support in understanding how the technology can be utilised to further enhance the collaborative learning experience.

The CTLC has been described as a 'happy accident' (Jamieson, 2005). It was founded upon an ambiguous notion of collaborative learning but through the development of a conceptual narrative of pods and modes, the CTLC has evolved into a technologically rich array of small and large classrooms in which collaborative learning takes place. Not all attributes of the CTLC have been successful, but as a result of learning from the CTLC the higher education community has been able to continue promoting, designing and building alternative interpretations of NGLEs.

The most influential aspects of the CTLC classrooms that have enabled effective teaching and learning to be practised are:

- the experiential qualities of the large and small classrooms
- the ability of students and teachers to move around the room
- the teacher being able to monitor student progress at a distance, especially in the small classrooms
- the 1:3 ratio of computers to students, enabling compter-based collaboration
- the convex and concave curvilinear shaped tables, supporting both collaborative and individual learning activities

Chapter 7 - Case Study 3: The Learning Lab, University of Melbourne

7.0 INTRODUCTION

The Learning Lab is a collaborative classroom, refurbished within the shell of a redundant tiered lecture theatre, resulting in a unique architectural quality and experiential ambience. Designed initially to aid the transformation towards a more interactive chemistry undergraduate tutorial program, the Learning Lab is primarily utilised by chemistry teachers and first year students, although its purpose was conceived to have far wider application. The Learning Lab has gained worldwide interest, attracting visits from international university colleagues as well as enthusiasm from the Australian community of TEFMA. As this chapter outlines, the uniqueness of the Learning Lab lies in its transformation of a redundant lecture theatre, generating a visionary design response that considered the dual pedagogical and spatial requirements to facilitate student-centred collaborative learning.

The evaluation of the Learning Lab included two groups of participants: 1) key project stakeholders involved in the design and procurement of the space; and 2) academics who teach in the Learning Lab. The key project stakeholders interviewed for this research project included the architect, the facility manager, the project manager, the technology manager (TM) and the LED. The LED at the University of Melbourne was also the LED for the University of Queensland. The four academic participants, referred to throughout this chapter as T1–T4, all teach chemistry to first year students. They were interviewed prior to the in situ observational studies. T1 was the primary academic stakeholder who participated in the briefing and design process, acting as a representative for his chemistry academic colleagues.

All observed classes were of 1-hour duration and supported by 3 hours of lectures (conducted in a lecture theatre, either before or after the tutorial, depending upon timetabling) and a laboratory session (3 hours per fortnight). The interviews and observations all related to the same first year chemistry subject and took place across Weeks 2, 3 and 5 of the first semester.

7.1 UNIVERSITY CONTEXT

In the late 1990s the university was cognisant of the need to build collaborative learning environments in response to developing pedagogical approaches, identifying a number of spaces suitable for renovation (Dodds, 1999). One of these spaces was known as the West Theatre 169 in the Chemistry Building at the centre of the campus. This space was a tiered lecture theatre, approximately 135 m2, with capacity for 94 students.

In 2006, the project was approved to proceed to design and construction, becoming operational in early 2007. The room is no longer a lecture theatre, but rather, provides a space for weekly tutorials for over 1,000 first year chemistry students, and has been renamed the Learning Lab.

The Learning Lab is located at the heart of the campus, in the west wing of the Chemistry Building (Figure 91). It is a multi-level space with internal access at first floor level and doors opening to the west at ground level, into Macfarland Court. The majority of occupants enter and exit the space from within the Chemistry Building.

Figure 91: Location of Chemistry Building on the Parkville campus

7.2 ORIGINS OF THE LEARNING LAB

7.2.1 Catalyst

The chemistry program across all year levels was organised around a combination of lectures, tutorials and laboratory practice. Plans were in place to adapt the laboratory curriculum to align with the anticipated upgrade of the laboratory facilities, which generated significant optimism for the quality of the laboratory program. The lectures were considered essential for introducing specific concepts to large cohorts before breaking into small groups for tutorials. However, it was observed that the tutorials were becoming quasi lectures, particularly when they were timetabled into small lecture theatres because standard tutorial rooms being unavailable. Despite attempts by some academics to implement interaction and activity during the tutorials, most teachers realised the tutorials were fundamentally didactic learning experiences for their students. For example, T1 said:

> *The tutorials were given in lecture theatres. And, if it looks like a lecture, quacks like a lecture, it probably is a lecture. People are sitting up there in rows, you can try and engage in a conversation; you could answer occasional questions that people might ask you; you can ask them some questions and so on, but a discussion is difficult. Getting people to collaborate together is difficult.* (T1)

The LED described his starting point:

> *It was explained that they were conducting very unsatisfactory tutorials that were basically becoming didactic teaching sessions where the tutor was standing at the front of the class and lectured back to the students who were meant to be in a tutorial situation. And what they wanted to do was make a much more interactive experience with the students and they needed a different sort of classroom to do that in.* (LED)

After several years of planning to upgrade the West Theatre, a number of synchronous events aligned to achieve the necessary approvals to proceed: 1) the arrival of the LED who had previous experience of designing collaborative learning spaces; 2) academic grant funding to redevelop the chemistry tutorial curriculum to be more interactive and technology based; and 3) funding approval to refurbish the West Theatre. It is unlikely that the resultant Learning Lab would have eventuated without the synergies of these crucial elements.

7.2.2 Curriculum Change

T1 was one of the recipients of academic funding to redevelop the chemistry tutorial curriculum, and was simultaneously appointed to the project design committee for refurbishment of the West Theatre. T1 and the LED met in the West Theatre to discuss directions for the new tutorial curriculum and types of learning activities to be implemented, including, collaboration, discussion, access to internet resources and so on. LED provided an educational framework to support the new curriculum, hypothesising the structure of group work and how this might be applied in the space:

> *I described to [T1] how the room should be oriented to the walls and you could form small groups. We would use the walls to provide surfaces for all the students to work on so that the room would radiate away from the centre of the space and the students' direction would principally be away from the teacher towards the wall so that they would work in groups. In that same meeting, I also proposed the idea of steps based on the idea of having a cabaret classroom.* (LED)

The TM responded to the educational vision, drawing from case studies at MIT and the University of Queensland to propose educational technology solutions. The architect synthesised this information into a spatial proposal, and the whole process was coordinated by the University's Property and Campus Services project manager. However, the fundamental ideas embedded in the Learning Lab were established by T1 and LED at their first meeting that took place in the West Theatre:

> *And so we [T1] had this discussion where we sort of fed off each other onsite ... and it just seemed to be a momentum where he didn't resist these outrageous ideas and contributed to pursue them. But the essence of the design appeared in that first conversation and it hasn't changed.* (LED)

7.2.3 ***Capacity of the Room***

Determining the capacity of the room was inextricably linked to space management issues: who should have access to the facility? After considerable discussion, the LED suggested that first year students would benefit the most, establishing good tutorial practice from the beginning of their university experience. While this was agreed as an equitable solution, the dilemma was delivering an effective tutorial program to over 1,000 first year chemistry students. Was it possible to conduct and repeat tutorials in a single space for that many students? Significant tension arose between the objective of timetabling tutorials for 1,000 students and the maximum capacity of the room: the higher the capacity, the more students could be timetabled each week.

Drawing upon previous experience, the LED intuitively believed that 40 occupants was the physical maximum, whereas T1 believed 60 occupants was the optimum number. The LED was conceptualising the space required between student groups to prevent noise distraction and to ensure each group would be located adjacent to a wall; T1 was considering how they could ensure every first year student could be timetabled equitably:

> *One of the design things I tried to do very consciously in this project was to form some separation between the groups … What I thought we could do with the steps was create a sense of separation … my presumption all along was that if we could get people to be, in a sense, out of kilter spatially they would be primarily aware of their own group and themselves in that group and have a very secondary awareness of everybody else in the room.* (LED)

> *If there are 40 people in the room I think it is very full. However, had we made it five groups of six then ... we couldn't have got the number of students through in a week; it just wouldn't have worked.* (T1)

After considerable debate, negotiation and timetable modelling, the capacity of the room was capped at 40 students, with the consequence that tutorials could only be programmed for 1 hour. The LED was concerned that a 1-hour tutorial would diminish the extent of collaborative learning that would be possible in the space, stating:

> *the educational approaches that I was trying to foster in there were about collaboration and interaction and communication and I just don't see how you can really draw on the full potential of that environment, the physical space we've created, and do all of that within an hour's duration.* (LED)

7.3 PEDAGOGY AND DESIGN

How did pedagogy inform the design process? The primary driver of the design was the pedagogical priority to increase interaction among students. Use of educational technology in learning activities was also a major aim, with the TM playing a pivotal role during design. The LED responded to the vision expressed by T1 by providing a crucial educational framework, which had direct implications for the spatial planning. Drawing upon his previous experience of contributing to the design of the CTLC at the University of

Queensland (see Chapter 6), the LED knew the number of students able to authentically collaborate together was the crucial determinant. The CTLC was centred around groups of 18 students, which was deemed to be pedagogically ineffective. Collaborative learning literature often recommends three to six people as an ideal number for group work and the LED expressed that planning for groups of three or six was preferred. However, as the maximum capacity of the Learning Lab was established at 40 students, the collaborative settings naturally formed as 5 groups of eight or as 10 groups of four.

The other unique pedagogical idea was that student groups would have access to the same technology afforded to the teacher. Collaborative settings commonly provided students with access to whiteboards, but it was unusual to provide student access to LCD screens where they could locally project the product of their interactions. This had been attempted in the larger classrooms of the CTLC at the University of Queensland, but using data projectors, rather than LCD screens.

7.3.1 Architect's Response

The architect realised early in the project that this was not a brief to design a traditional learning environment. He was challenged and excited at the prospect of working with the LED, and surprised at the comparatively large budget that continued to grow in response to technology, furniture and ambient characteristics. The architect explained:

> *It was the first time we were going to be able to do an integrated design and we'd take into consideration the users and really had a chance to talk with the users … The AV [audio visual] guys had been in really early and it had been like: what can we do in the space? I don't think really anyone quite knew what it was when we started out so it was really a chance to just think outside the box and find the best way to make it exciting. It wasn't just a case of putting paint on the walls, it was really to try and make it an interesting, exciting kind of space.* (Architect)

The architect responded initially to the pragmatic brief: to plan for five groups of eight students, while managing the egress and access issues demanded by the building code. The height of the space and the requirement to maintain access from inside the Chemistry Building, as well as providing access for disabled people, predisposed the space to the notion of platforms. The challenge for the architect was the notion of making a learning environment 'exciting', an idea that in his experience did not ordinarily transcend to classrooms:

We were talking of how are we going to make this room exciting and not just have walls with whiteboards stuck on them and drop-down screens … and then went with this image of Alvar Aalto. It was one of his exhibitions he'd done in Finland. I think it was where he had all these curved walls that were hung off and that was the inspiration for it and when we did that, that was very exciting because it gave us some depth to the room that we could play with, we could bring in colour, we could still meet the practicalities projecting onto a white wall. (Architect)

The architect was receptive to guidance provided by the LED and T1. Together they created a narrative for teaching and learning that the architect was able to spatially translate and refine.

7.3.2 Size and Finishes

The Learning Lab occupies the same footprint and volume as the previous lecture theatre, but the tiers of the lecture theatre have been replaced with a series of platforms forming five distinct zones of activity to house a maximum of 40 students (Figures 92- 94). One of the characteristics of the space that immediately sets it apart from other classrooms is that there is colour in the room. Low-level orange joinery and receding yellow walls frame a series of protruding, curved, white panels that wrap the room, softening the otherwise rectilinear shape (Figures 95- 98). A series of LCD screens and whiteboards is located on white panels serving to define each zone of activity. The orange joinery provides open shelving for student belongings and other resources for the room.

Sight lines in the room are maintained via the placement of clear toughened glass balustrading to separate platforms. A major column is located in the room, but the activity zones have been placed around the perimeter of the room to maintain integrity of sight lines to the teacher. However, there are a few positions in the room where some students may not have a direct line of sight to all other students. The column is opportunistically used as a location where dry chemistry demonstrations can be conducted by the teacher, using an overhead video camera to broadcast to the LCD screens around the room.

The new ceiling is approximately 4 m above the lowest floor level, from which a system of energy-efficient lighting is suspended. A variety of possible lighting settings relate to particular TLAs, including dark (presentation mode), general task lighting (group work) and pinpoint lighting over each zone (focused activity). Neutral grey carpet is laid on the floor and steps, along with the required safety adornments of floor indicators and rubber nosing to the edges.

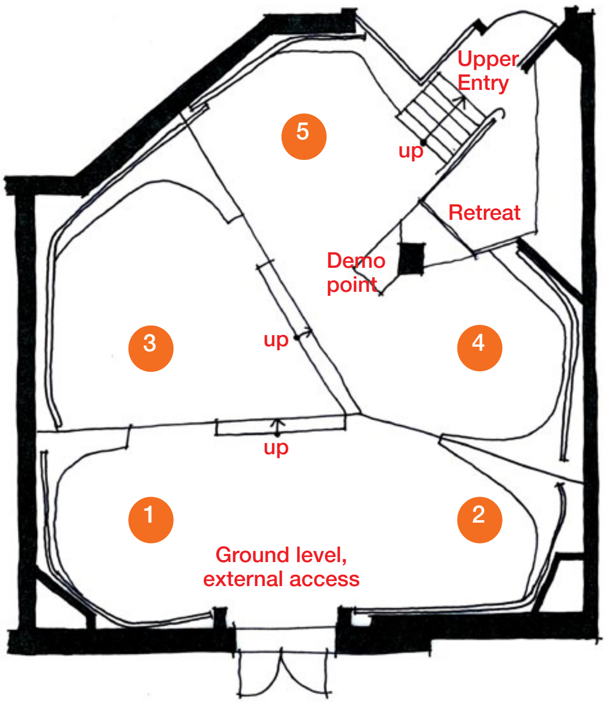


Figure 92: Zoned layout of the Learning Lab
Source: Author

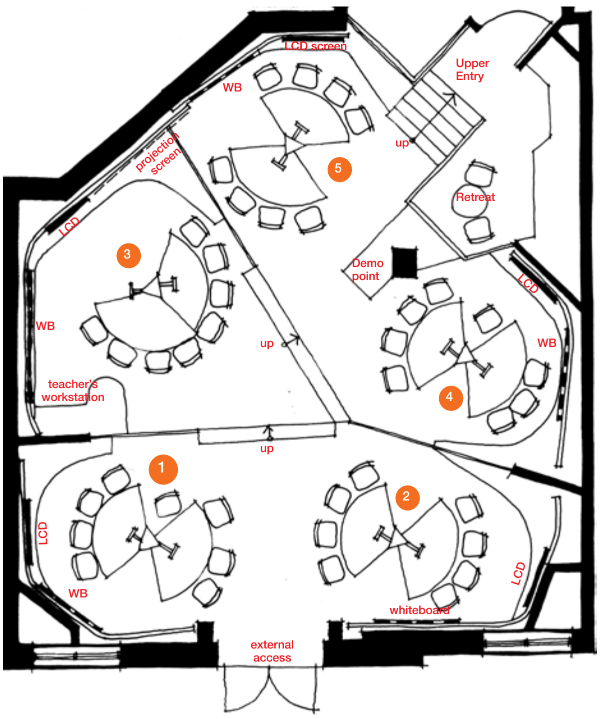


Figure 93: Furniture layout of the Learning Lab
Source: Author

7.3.3 Design Features

Five furniture settings have been duplicated throughout the room, each seating eight students (Figure 93). Each setting forms a zone consisting of a table, eight task chairs, two fixed desktop computers, a whiteboard, an LCD screen and access to the perimeter storage unit (Figures 99- 102). A document camera also sits on the joinery in each zone. The table top consists of two rotating sectors, each shaped like a pizza wedge, enabling students to manoeuvre the tops according to their activities and groupings. Each table sector seats four people and one tabletop sector can rotate underneath the other, creating the capacity to reduce table area and increase floor space in each zone.

Figure 94: Learning Lab digital model by Architects, Blomquist Wark.
Source: Blomquist Wark

Figure 95: The Learning Lab from the upper entry
Source: Author

Figure 96: Furniture setting of a zone
Source: Author

Figure 97: Learning Lab from the ground floor
Source: Author

Figure 98: Zone of activity
Source: Author

Figure 99: Teacher's workstation
Source: Author

Figure 100: Student activity with help from a TA
Source: Author

Figure 101: Student activity
Source: Author

Figure 102: Technology available to each zone
Source: Author

OBSERVATIONS:

- General Pre-observations
- Pre-observations 1
- Osbervation 1
- Summary Observation 1
- Pre-observations 12
- Observation 2
- Summary Observation 2
- Pre-observation 3
- Observation 3
- Summary Observation 3
- Pre-observation 4
- Observation 4
- Summary Observation 4

GENERAL PRE-OBSERVATIONS

The teacher's workstation is located on the middle platform, located adjacent to a wall so as not to be a dominant feature in the room (Figure 99). This workstation contains a fixed desktop computer and document camera, and is connected to a ceiling-hung data projector that projects a large-format image to one of the white walls. A technology console, usually operated by the teacher, controls the LCD screens around the room and the data projector. The screens can be operated synchronously or independently according to the activities being undertaken.

Although originally created as a chemistry classroom, and despite its location in the Chemistry Building, the Learning Lab was designed to support student-centred, collaborative learning broadly across a range of disciplines.

7.4 OBSERVATIONS

7.4.1 Introduction

As a result of the teaching and learning grant that enabled redevelopment of the curriculum, each tutorial was supported by two teachers: the tutor and a teaching assistant (TA). The TA would help set up the Learning Lab prior to the tutorial in readiness for the planned experiments and activities. During student activities the TA would provide additional support to the tutor by moving around the room offering assistance to students, answering their questions, seeking confirmation from students that they understood the concepts being presented to them.

7.4.2 Teachers' Intentions of Class to be Observed (Pre-observation)

Prior to semester, the team of chemistry tutors established a program for the semester's curriculum, including lecture topics, tutorial activities and laboratory activities. The tutorials had an accompanying workbook containing problems to be completed each week, including online problems that were expected to be completed prior to attending the tutorial. There was a predetermined program of content that was expected to be covered by all tutors each week. Tutorials may vary during the week depending on whether the lecture had preceded the tutorial or not. Some teachers discussed the need to cover lecture material as background to the tutorial activity, if the tutorial was timetabled prior to the lecture. Sometimes an additional tutorial was scheduled at the end of semester to ensure that all students had access to the full tutorial program.

GENERAL PRE-OBSERVATIONS

There appeared to be a strong emphasis on explaining theory and concepts to students, especially where the tutorial may have been timetabled prior to the lecture. This was described as a problem by academics in this situation, resolved by either: a) conducting a mini-lecture at the beginning of the tutorial to ensure students understood key concepts for the tutorial activities; or b) conducting an additional tutorial at the end of semester, to ensure the lecture always preceded the tutorial.

The emphasis on explaining may have been a consequence of the stage of semester, with students being required to understand a number of key introductory concepts prior to applying the theory to different scenarios. This presented the possibility that use of the facility may vary dramatically depending on the stage of semester, and that this study needed to consider the potential activities enabled by the space, rather than just the observed encounters themselves.

What was particularly surprising was that while each of the academics supported the notion of student collaboration and interaction, they conveyed no intention to adopt the structured groups of four or eight students envisaged during design. Further, the academics did not intend to create any structured group work, believing that students did not necessarily like being 'put' into groups. Instead, group work was to be encouraged as a peer-to-peer arrangement. T3 went as far as suggesting that collaborative learning was being 'forced' upon him and that it did not align with his approach to teaching.

All of the classes were intended to commence with an address by the academic to reiterate concepts from the preceding lecture. This would be followed by the teacher presenting a series of problems to be completed during the tutorial. The first one or two problems would be led by the teacher with students working through the remaining problems. The teachers planned to then lead a discussion on the problem answers, seeking responses from the students.

7.4.3 Potential Activities in the Learning Lab

It became apparent during interviews with the teachers that numerous learning activities would be undertaken in the Learning Lab during the semester, but were not anticipated to be observed by the author within the timeframe of the data collection (see Table 14). The top two rows outline the activities that were anticipated, the middle two rows list activities that were discussed by teachers as taking place at other times of the semester and the bottom row is a list of activities that were considered possible by the author, but were not raised by the teachers.

GENERAL PRE-OBSERVATIONS

These unobserved activities indicate that use of the Learning Lab provides a more engaging student learning experience than the observed episodes revealed. This indicates that activities can and do vary across the semester, within the same subject. It is the potential to conduct a variety of activities that encapsulates a NGLE. This breadth of activity is difficult to apply in a single teaching space such as a lecture theatre, general teaching space or computer laboratory. Therefore, the possibilities and potential within a NGLE presented as a unique characteristic to be further considered.

For each observation the researcher sought to record the following detail:

1) descriptions of student and teacher activities throughout the tutorial, including movement of the teacher and TA during student activity

2) categories of TLAs

3) duration of each TLA.

Table 14: Anticipated and Potential Activities in the Learning Lab

Anticipated student activities	Anticipated teacher activities
- Discussion - Answering questions - Model building - Access ChemCal (online interactive software) via fixed desktop computers - Access the internet via fixed desktop computers (search for information)	- Explaining/lecturing - Asking/answering questions - Demonstration using the document camera - Working with multiple images across multiple screens
Potential student activities discussed by the teachers (Not anticipated for the observations)	**Potential teacher activities discussed by the teachers (Not anticipated for the observations)**
- Students presenting to other students - Students presenting to the whole class, with or without the document camera - Use student response keypads ('clickers') - Producing work on screen - Projecting student work to the local LCD screen	- Demonstrations at the demo point - Play movies/animations and video - Use student response keypads ('clickers') - Simulations - Conduct safety briefing using a virtual tour of a laboratory
Potential student activities not discussed by teachers	**Potential teacher activities not discussed by teachers**
- Working in structured groups of 4 or 8 - Longitudinal project based work - Watch a feature length movie - Perform - Role play - Symposium of students	- Set structured group work activities - Set longitudinal problems/projects - Debate - Connect to remote students or experts via video conference or programs such as Skype - Symposium of experts

PRE-OBSERVATION 1

7.4.4 Pre-observation 1

T1 described the following planned activities for the chemistry tutorial:

- discussion and encouraging students to ask questions
- working through chemistry problems.

> *Collaborative work is one thing, and this is the space—the Learning Lab is the space that allows that, but even simply providing an opportunity where our students could, in a better way, ask questions and have questions answered; listen to what other students were asking, and hear what they were told.* (T1)

T1 described an approach to teaching that would require students to interact with the teacher through discussion, questions and working through the designated chemistry problems. There was no apparent intention to conduct any formal group work, despite the fact that T1 was one of the primary academic stakeholders who had a clear understanding of the design and pedagogical objectives of the space. T1 discussed the benefits of creating an interactive tutorial; however his conception of interactivity appears to be limited to interaction occurring between the teacher and students, rather than among students in the form of small group work.

OBSERVATION 1

Table 15: *Observation 1 Timeline*

Teachers: T1
Students: 1st Year
Date: MONDAY, WEEK 2, SEMESTER 1, 2:15 – 3:15pm
Number of students: 29
Duration of class: 1 hour

LEGEND

- Category 1, Teacher-directed (black)
- Category 2, Teacher-led interactive (grey)
- Category 3, Student activity (orange)
- Category 4, Student presentation (blue)
- Start/Finish class (white)

TIME	ACTIVITY	FEATURE ACTIVATED
2:15pm	– Class started. – T1 Introduced himself and introduced me. – Introduced process. – Introduced questions.	– Centre of the room, zone 3.
2:30pm	– Group work/respond to questions from workbook.	– All tables and zones.
2:35pm	– Back to T1 (in central space) to respond to questions – Questions directed to tables 1, 2, 3, 4 & 5 in sequence. (Questions displayed on all screens) – **Figures 103, 107 & 108**	– Centre of the room, zone 3.
2:45pm	– T1 at teacher's workstation, using document camera and displaying different question to class. – Repeats answer to ensure everyone heard.	– Teacher's workstation.
2:50pm	– Central address. – Focused some questions to students. – TA sitting on steps at back.	– Centre of the room, zone 3.
3:00pm	– Small groups answering questions – **Figures 104 & 109**	– All tables and zones.
3:05pm	– T1 addressing whole class.	– Centre of the room, zone 3.
3:15pm	– Class ends.	

OBSERVATION 1

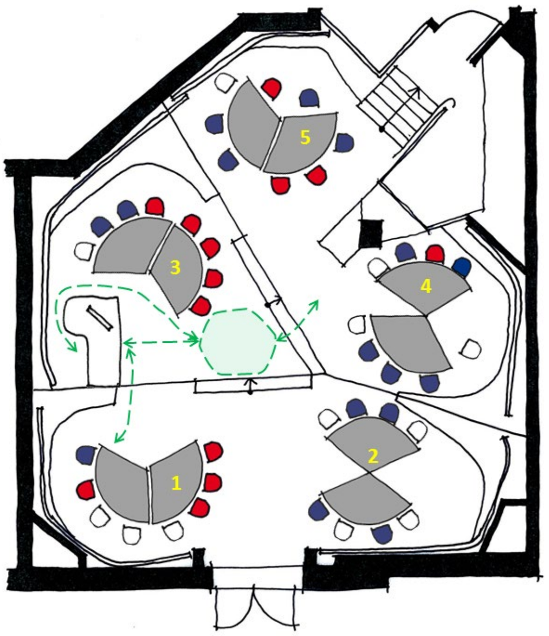


Figure 103: Observation 1
Teacher T1 Movement during Teacher-Directed and Teacher-Led modes.
Source: Author

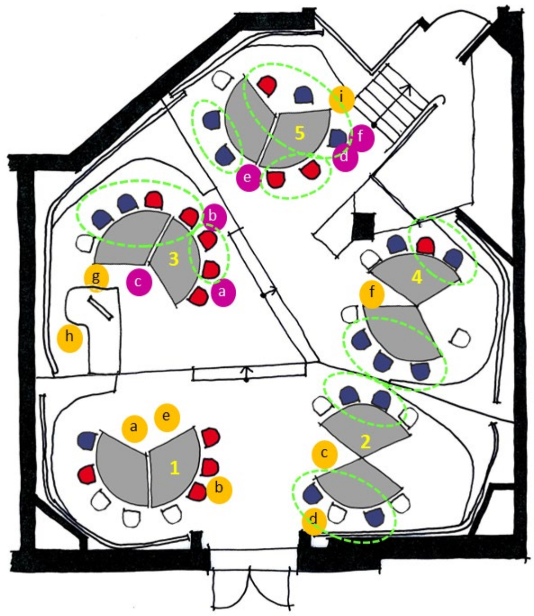


Figure 104: Observation 1
Sequence of Teacher T1 and teacher assistant (TA) movement during student activity
Source: Author

T1 gravitated to the centre of the room in zone 3, moving back and forth to the teacher workstation to control the data projections. Occassionally T1 moved up the steps to zone 4 or down steps to zone 1.

- T1 covered all zones and interacted with students at every setting
- TA was biased towards zones 3 & 5
- Students in zone 4 received the least attention from teachers
- Students in zones 3 & 5 received the most attention from teachers

LEGEND

Unoccupied seat

Female occupant

Male occupant

Self-organised clusters of student groups

Zone ID number

Sequence of T1 interactions with students

Sequence of TA interactions with students

OBSERVATION 1

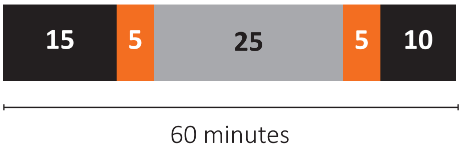


Figure 105: Observation 1 Timeline

	% Class Time Observation 1
Category 1, Teacher-directed	**42%**
Category 2, Teacher-led interactive	**42%**
Category 3, Student activity	**16%**
Category 4, Student presentation	-
Start/Finish class	-

Figure 106: Percentage of teaching & learning categories during Observation 1.

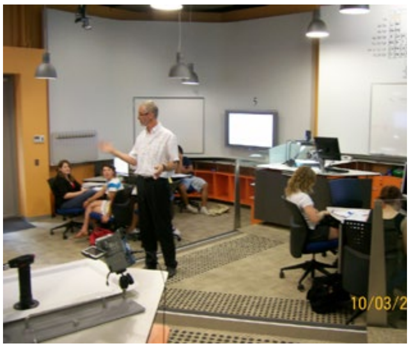


Figure 107: Observation 1, Teacher-led interactive
Source: Author

Figure 108: Observation 1, Teacher-led interactive
Source: Author

Figure 109: Observation 1, Student Activity
Source: Author

OBSERVATION 1

7.4.5 Summary Observation 1

T1 began and ended the class in 'teacher-directed' mode, which consumed 42% of total class time, refer Figure 106. For the first 15 minutes T1 explained the workbook problems to be completed during the tutorial and related them to the lecture. At the end of class, T1 spent 10 minutes recapping the workbook problems, explaining the answers in full.

There was surprisingly little opportunity for students to work together to complete the workbook problems. On two occasions T1 instructed students to spend 5 minutes working on a particular problem (16% of total class time) and this represented the extent of collaborative activity. There was no instruction to work in groups of four, or in any group structure. While discussion was encouraged, students were not instructed to work in any particular way. While students were working on the set problems, T1 and the TA moved around the room, visiting each zone to respond to student questions and ensure everyone knew what they were doing.

T1 spent 42% of class time (25 minutes) leading an interactive discussion, refer Figure 106. T1 asked questions to the class and led them through some workbook problems, explaining concepts and processes for understanding. During this time T1 was located in the centre of the room, moving around in the open space in front of the teacher's workstation, and moving to and from the educational technology he was utilising. His teaching style was quite animated and dynamic and he had no difficulty eliciting responses from the class. However, the fact remains that students spent 84% of the class time in a didactic situation and only 16% of the time undertaking an activity.

Given T1's enthusiasm for the variety of activities that are possible in the Learning Lab, it was surprising that he spent the majority of the class addressing the whole cohort (teacher-directed and teacher-led interactive). Despite the potential for collaborative learning activities, afforded by the room's spatial characteristics, the observed tutorial was dominated by the teacher.

PRE-OBSERVATION 2

7.4.6 Pre-observation 2

T2 described the following planned activities for the chemistry tutorial:

- 'traditional teacher'
- explain relevant theory
- describe approach to working through chemistry problems
- work through chemistry problems
- encourage discussion (ad-hoc, not structured)
- build chemistry models.

There's also other questions where they will build molecules so that will probably be a good one where they'll all have their little model kits and they'll build models. So that will be more me and the tutor walking around helping them. So the first two or three questions will be me just walking them through it and then the last question I'll sort of let them go off on their own and build these models. (T2)

OBSERVATION 2

Table 16: *Observation 2 Timeline*

Teachers: T2
Students: 1st Year
Date: TUESDAY, WEEK 2, SEMESTER 1, 2:15 – 3:15pm
Number of students: 33
Duration of class: 1 hour

LEGEND

Black	Category 1, Teacher-directed
Grey	Category 2, Teacher-led interactive
Orange	Category 3, Student activity
Blue	Category 4, Student presentation
White	Start/Finish class

TIME	ACTIVITY	FEATURE ACTIVATED
2:20pm	– Class started. T2 introduced herself and me. – T2 contextualised self, provided contact details (on whiteboard) – Established first concept, referred to homework. – Showed animation from teacher's workstation – projected to all LCD screens plus large projection wall. – Asked questions to class (lots of responses from students) – Instructed class to do question 1. – **Figures 110 & 114**	– Teacher's workstation – LCD screens – Centre of the room, zones 3 & 4
2:30pm	– T2 and TA wander around space assisting students. – A couple of minutes later T2 drew example on document camera to demonstrate how to do activity. – T2 responds to student questions; checking for understanding. – Student activity...students in discussion. – Evidence of students discussing & collaborating – not everyone though. – **Figures 111 & 116**	– All tables and zones – Teacher's workstation and document camera
2:53pm	– T2 back to centre addressing class...confirming answer to Q1, then moving on to Q2. – Responding to student question using document camera at teacher's workstation. – **Figure 115**	– Centre of the room, zones 3 & 4
3:00pm	– Concern about time (T2 facial expression). – T2 in centre walking around, discussing Q2.3. – TA hands out modelling kits – one per person. – T2 constantly asking cohort to answer brief questions with show of hands.	– Centre of the room, zones 3 & 4
3:05pm	– T2 requested everybody answer Q2.4 by building model. – T2 and TA assist students as required. – T2 checked briefly with each table to make sure they were doing the activity correctly.	– All tables and zones
3:10pm	– T2 handed over to TA for a demonstration using the document camera. – TA at teacher's station using 'plates' and containers of water. – T2 standing on lower tier next to teacher's station. – TA explaining demonstration. T2 reinforcing key points.	– Teacher's workstation and document camera
3:15pm	– Students start to leave. – TA packs up modelling kits. – Class ends.	

OBSERVATION 2

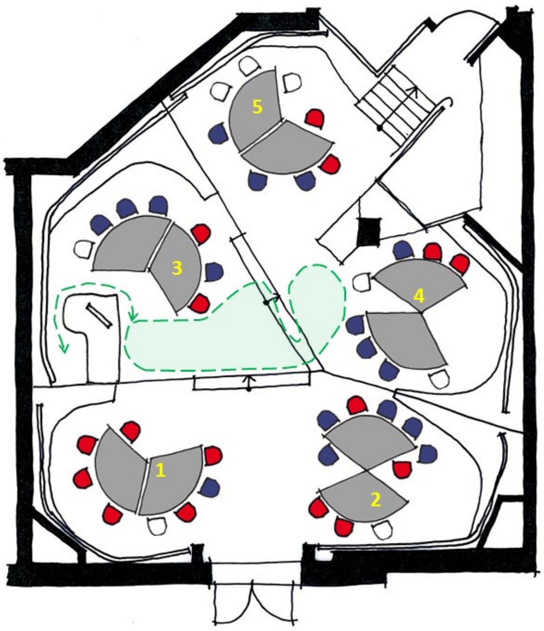


Figure 110: Observation 2
Teacher T2 Movement during Teacher-Directed and Teacher-Led modes.
Source: Author

T2 gravitated to the centre of the room across zones 3 & 4, moving back and forth to the teacher workstation to control the data projections.

Figure 111: Observation 2
Sequence of Teacher T2 and teacher assistant (TA) movement during student activity
Source: Author

- T2 appears biased towards zones 1 & 2
- TA was biased towards zones 4 & 5
- Students in zone 3 received the least attention

LEGEND

Unoccupied seat

Female occupant

Male occupant

Self-organised clusters of student groups

Zone ID number

Sequence of T2 interactions with students

Sequence of TA interactions with students

OBSERVATION 2

Figure 112: Observation 2 Timeline

	% Class Time Observation 2
Category 1, Teacher-directed	**17%**
Category 2, Teacher-led interactive	**28%**
Category 3, Student activity	**47%**
Category 4, Student presentation	**-**
Start/Finish class	**8%**

Figure 113: Percentage of teaching & learning categories during Observation 2.

Figure 114: Teacher-directed
Source: Author

Figure 115: Teacher-led interactive
Source: Author

Figure 116: Student Activity
Source: Author

OBSERVATION 2

7.4.7 Summary Observation 2

The observation proceeded as T2 anticipated, but even as T2 was addressing the cohort to explain the problems to be completed, she did so in an animated, interactive manner. Students appeared to offer their responses eagerly. T2's previous tutorial teaching practice (in a lecture theatre) did not sound significantly different to that observed in the Learning Lab. Compared with T2's experience of stagnant student participation in tutorials located in the lecture theatre, there appeared to be considerable engagement from students responding to T2's questions.

After 10 minutes of teacher-led interaction, T2 instructed students to start working on the designated problems. She did not instruct students to work in groups. T2 and the TA proceeded to move around the room, responding to student questions and ensuring everyone understood what they were doing. Many students were in discussion with their peers, but some students were not. T2 and the TA allowed students to work independently.

With 15 minutes remaining, T2 appeared to realise they were running out of time to complete the problems; the modelling task had not been undertaken at that point. T2's facial expression indicated concern regarding time. Students were given the opportunity to do some modelling, but T2 spent the remainder of class in didactic mode, instructing the class on what they needed to know. The TA demonstrated a chemistry experiment under the document camera; however this was quite rushed and T2 was simply explaining the principles, rather than instigating any interaction with students.

PRE-OBSERVATION 3

7.4.8 Pre-observation 3

T3 described the following planned activities for the chemistry tutorial:

- discussion based
- explain concepts to students
- ad-hoc collaboration allowed but not explicitly encouraged
- build chemistry models.

> *I'm not likely to change the way I do things. I know there's a lot of emphasis about group work and interaction. That's good but I really think one of the best ways to learn is to listen to people who know a bit about something, who guide what you're doing … Now it doesn't mean you don't get interaction. It doesn't mean you don't do group work, but that's probably the way I work. I'll adapt what I'm doing to a space ... but I don't throw out the way I work. I think universities are a bit guilty of forcing teaching styles on people.* (T3)

T3 appeared to have a teacher-centred disposition to teaching rather than the student-centred, collaborative approach conceptualised during design. T3 considered himself a traditional teacher who was not likely to change his teaching practice despite the design of the environment presenting numerous possibilities for a variety of learning activities. It was expected that T3 would facilitate a primarily teacher-led, discussion-based tutorial.

OBSERVATION 3

Table 17: *Observation 3 Timeline*

Teachers: T3

Students: 1st Year

Date: TUESDAY, WEEK 3, SEMESTER 1, 10:00 – 11:00am

Number of students: 34

Duration of class: 1 hour

LEGEND

- Category 1, Teacher-directed
- Category 2, Teacher-led interactive
- Category 3, Student activity
- Category 4, Student presentation
- Start/Finish class

TIME	ACTIVITY	FEATURE ACTIVATED
10:05am	– Start class. Introduce me. – T3 stated what they should know by the end of class; explanation. – Demonstration using document camera & description (standing behind teacher's workstation). – Questions displayed on LCD screens. – Everyone looking at image on large projection wall (from doc. Camera).	– Teacher's workstation – LCD screens
10:15am	– T3 came out to 'centre' (in front of teacher's workstation) and asked questions to students, then back behind teacher's workstation to do more demonstration on document camera. – Briefed students on first problem to work on, estimated 10 minutes on problem activity. **Figure 117 and 121**	– Teacher's workstation – Zone 3 – Document camera
10:20am	– Switched document camera image to LCDs to discuss with students at group 3.	– LCD screens
10:23am	– T3 back to teacher's workstation to explain answer. – T3 commented that some people can't see large screen, so put questions on large screen and document camera image on LCDs.	– Teacher's workstation – LCD screens
10:25am	– Everyone working on problems. Very little collaboration going on. T3 asked student at group 1 to help late comer. **Figure 118 and 122**	– All tables and zones
10:35am	– T3 brought everyone back to focus. – Document camera image on large screen and LCDs. – T3 explained question and answer from behind teacher's workstation. He asked one question to class. – T3 came out in front of teacher's workstation.	– Teacher's workstation – LCD screens
10:37am	– T3 introduced next question on LCDs (estimated duration 1 min.) **Figure 118** – T3 checking that everyone understands answer and stops to explain where necessary...sometimes talking to one student, sometimes to whole table.	– Teacher's workstation – All tables and zones
10:40am	– Focus back on T3...he explained answer. – Introduced new concept to prepare for final question, using document camera... concept to be discussed in lecture. – When using document camera, T3 stands behind teacher's workstation (cannot do this anywhere else). – When explaining and not using document camera, T3 comes out in front of teacher's workstation.	– Teacher's workstation – Document camera
10:45am	– T3 instructed class to tackle next question, estimated duration: 5 minutes. – **Figure 118 and 123**	– All tables and zones
10:50am	– Back to focus on T3. – He explained answer: document camera image on large screen; questions shown on LCD screens...T3 switched document camera image to LCDs. – T3 asked who got question right. – Next answer...same image on large screen and LCDs. – Called for questions from class (none).	– Teacher's workstation – Document camera – LCD screens
10:55am	– Class ends.	

OBSERVATION 3

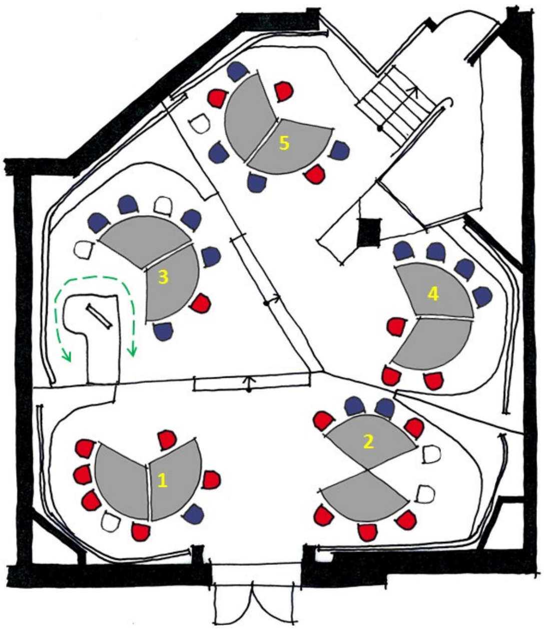


Figure 117: Observation 3
Teacher T3 Movement during Teacher-Directed and Teacher-Led modes.
Source: Author

Figure 118: Observation 3
Sequence of Teacher T3 and teacher assistant (TA) movement during student activity
Source: Author

LEGEND

- Unoccupied seat
- Female occupant
- Male occupant
- Self-organised clusters of student groups
- Zone ID number
- Sequence of T3 interactions with students
- Sequence of TA interactions with students

OBSERVATION 3

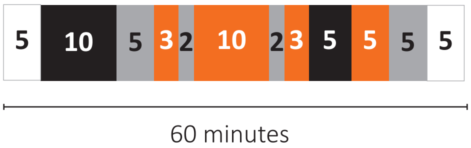


Figure 119: Observation 3 Timeline

	% Class Time Observation 3
Category 1, Teacher-directed	**25%**
Category 2, Teacher-led interactive	**23%**
Category 3, Student activity	**35%**
Category 4, Student presentation	**-**
Start/Finish class	**17%**

Figure 120: Percentage of teaching & learning categories during Observation 3.

Figure 121: Observation 3, Teacher-directed
Source: Author

Figure 122: Observation 3, Student Activity
Source: Author

Figure 123: Observation 3, Student Activity
Source: Author

OBSERVATION 3

7.4.9 Summary Observation 3

Despite the initial perception that T3's teaching practice would predominantly be 'teacher directed' or 'teacher-led interactive', which ultimately absorbed 48% of class time, T3 was evidently dynamic and engaging, refer Figure 120. He appeared to be completely in control of what students were expected to learn, how students were going to learn and how long they would take doing each activity. Although T3 did not formally instruct students to work collaboratively, there was evidence that students were collaborating. While students were undertaking their group tasks, T3 and the TA moved around the room to each zone, ensuring that students understood the concepts and how to solve the problems.

T3 moved quickly between modes, with no more than 10 minutes being spent on any one activity. If he addressed the class in didactic mode, this was generally not for long. Similarly, students were asked to complete quick tasks, often for only 3–5 minutes, with the longest student activity taking 10 minutes. In total, students spent 35% of class time undertaking prescribed activities. The time spent on each activity appeared to negate formal implementation of group learning, which would take time to organise.

PRE-OBSERVATION 4

7.4.10 Pre-Observation 4

T4 described the following planned activities for the chemistry tutorial:

- commence class by talking to students about concepts from lecture
- students to form their own groups
- students to build chemistry models
- T4 to interact with students while they work through activity.

> *This tute lends itself quite well to the room, particularly because I speak for about 8 minutes and then the students will make the models that we will be talking about, the kits that they've all got on their tables. And the assistant and I will walk around and help them and talk to them and talk through their problems. So that's the wonderful advantage of this room that you can actually have that sort of interaction, which was impossible in lecture theatres.* (T4)

T4 expressed a distinct disposition towards student-centred learning, and an explicit understanding of how the physical environment would assist in the implementation of student-centred learning. She had a clear plan for how long she would speak, how collaborative learning would be implemented during the tutorial and how the teacher and TA would interact with students to reinforce key concepts.

OBSERVATION 4

Table 18: *Observation 4 Timeline*

Teachers: T1

Students: 1st Year

Date: MONDAY, WEEK 2, SEMESTER 1, 2:15 – 3:15pm

Number of students: 29

Duration of class: 1 hour

LEGEND

Black	Category 1, Teacher-directed
Grey	Category 2, Teacher-led interactive
Orange	Category 3, Student activity
Blue	Category 4, Student presentation
White	Start/Finish class

TIME	ACTIVITY	FEATURE ACTIVATED
3:15pm	– Class starts. T4 introduced me and research project. – T4 discussed modelling activity – terminology and principles – located in centre of room. – Questions for student activity are projected onto large screen. – T4 projects document camera image onto LCD screens. – T4 back in centre explaining task. – **Figures 124, 128 and 129**	– Centre of room (zone 3) – Teacher's workstation – Teacher's workstation – LCD screens
3:28pm	– T4 instructs students to draw and model...each student constructing a model. (Modelling kits were distributed prior to commencement of class.) – **Figures 125 and 130**	– All tables and zones
3:50pm	– T4 calls class to attention from centre of room, then moves behind teacher's workstation to use document camera. – Asks questions to class, calls for answers. – T4 comes out to centre of room with model, establishes answer then moves back to document camera.	– Centre of room (zone 3) – Teacher's workstation – Document camera – LCD screens
3:55pm	– T4 brings model out to slide-out shelf, centre side of teacher's workstation, then moves back to behind workstation, to document camera to demonstrate models. – T4 moves back to centre of room to address whole class. – TA is drawing diagram on whiteboard to support T4's model demonstration.	– Centre of room (zone 3) – Teacher's workstation – Whiteboard
3:57pm	– T4 introduces question 2, from centre of room. – Instructs students what to do. Students given three minutes to respond. – **Figures 125 and 130**	– All tables and zones
4:05pm	– T4 in centre of room asking students for an answer to questions, checking for understanding.	– Centre of room (zone 3)
4:07pm	– Instructs students to do next exercise. T4 at document camera drawing diagram.	– All tables and zones – Document camera
4:11pm	– T4 at document camera explaining answer to whole class. – T4 rushes through last problem, explaining answer on document camera. Most students are watching their local LCD screen at document camera image.	– All tables and zones – Document camera
4:13pm	– T4 switches problem sheet to all LCD screens and confirms answers, interacting with students...they call out answers.	– Centre of room (zone 3) – Teacher's workstation – LCD screens
4:15pm	– Class ends.	

OBSERVATION 4

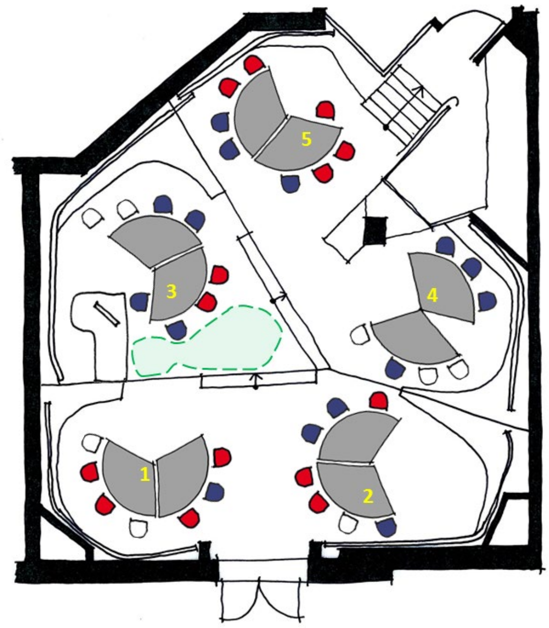


Figure 124: Observation 4
Teacher T4 Movement during Teacher-Directed and Teacher-Led modes.
Source: Author

Figure 125: Observation 4
Sequence of Teacher T4 and teacher assistant (TA) movement during student activity
Source: Author

T4 gravitated to the centre of the room in zone 3, moving back and forth to the teacher workstation to control the data projections.

- T4 appears biased towards zones 1 & 2
- TA was biased towards zones 3, 4 & 5
- Students in zone 4 received the least attention although they did have interaction with both T4 and the TA

LEGEND

Unoccupied seat

Female occupant

Male occupant

Self-organised clusters of student groups

Zone ID number

Sequence of T4 interactions with students

Sequence of TA interactions with students

OBSERVATION 4

Figure 126: Observation 4 Timeline

	% Class Time Observation 4
Category 1, Teacher-directed	**28%**
Category 2, Teacher-led interactive	**15%**
Category 3, Student activity	**57%**
Category 4, Student presentation	-
Start/Finish class	-

Figure 127: Percentage of teaching & learning categories during Observation 4.

Figure 128: Observation 4, Teacher-led interactive
Source: Author

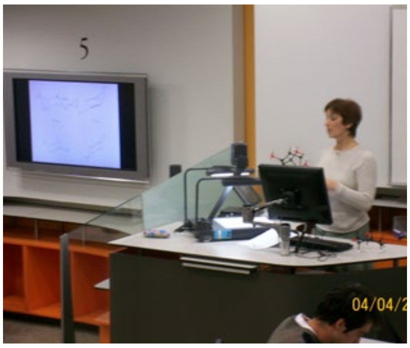


Figure 129: Observation 4, Teacher-directed
Source: Author

Figure 130: Observation 4, Student Activity
Source: Author

OBSERVATION 4

7.4.11 Summary Observation 4

T4 taught didactically for the first 13 minutes, explaining key concepts and the modelling tasks to be carried out by the students. Subsequently, students spent over half of the tutorial working on the models and the designated problems. There was no instruction to work in groups but it was evident that students were talking to their peers about the learning activities. It was surprising that even though group work was encouraged, each student was provided with a modelling kit, creating less need for students to work together. T4 and the TA moved around the room, discussing concepts and responding to student questions.

Of the four cohorts observed, this cohort spent the most time on specific student activities. Apart from the introductory monologue, T4 spent little time in didactic mode for the remainder of the tutorial, refer Figures 126 & 127. At all times, T4 appeared to be in control of what the students were doing, how students were going about the learning activities, and able to assist students. T4 appeared to cover the content required for the tutorial, although the final activity was hurriedly explained, rather than worked out by the students.

DISCUSSION

7.5 DISCUSSION

7.5.1 Design Features and Student-centred Learning

The key design features that positively influenced effective teaching and learning in the Learning Lab were:

1. the butterfly wing table configuration
2. platforms to create separation of student groups
3. clusters of technology available to students in each zone.

7.5.2 Butterfly Wing Table Configuration

The tables were custom designed to specifically facilitate groups of four and eight students working together (Figure 131). The two table leaves rotated on a central support column and when positioned together did not form a full circle. The educational concept was to have four students grouped around each table leaf with access to a desktop computer, and when the opportunity presented itself, the two groups of four students could interact as a group of eight. Two desktop computers were fixed on the table, one on each leaf, but the computer screens could be manoeuvred out of the way when not in use.

When the two table leaves were positioned together there was a gap of approximately 800 mm that had unintentionally become a useful position for the teacher to stand and have a focused discussion with students at the table. The table leaves could also overlap each other to increase the floor space around the table setting, which presented the opportunity for floor-based activities. Students could move the table tops around to suit the direction of their focus, which may be on the teacher in the centre of the room, the large projection wall, the local LCD screen or whiteboard; however, this action was not observed.

The purposeful design of the tables provided far more flexibility than a conventional single table top. In this sense the objective to implement effective teaching and learning in the Learning Lab was greatly enhanced by the design and location of the table settings.

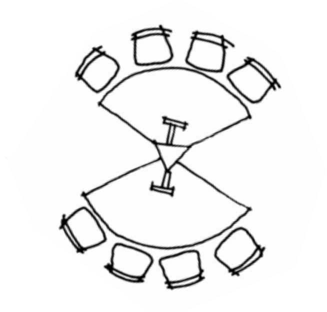


Figure 131: Butterfly Table Layout
Source: Author

7.5.3 Platforms to Create Separation of Student Groups

The volume of the Learning Lab resulted from the void left by the previous tiered lecture theatre. Access to the Learning Lab was required at the upper level, with connectivity from inside the Chemistry Building. However, access was also required at ground level to accommodate disabled access and a second path of egress. While a single ground floor planning solution was considered, the opportunity to design the learning environment over multiple levels was afforded by the vacant volume. Exploration of the height dimension led to the concept of platforms, which the LED likened to a cabaret setting, refer Figures 96- 98.

As space planning developed on the Learning Lab, and in the context of ongoing discussions on the capacity of the room, five natural zones emerged. Each zone was designed to suit no more than eight people, which led to agreement that the capacity of the room would be 40 students. Zones 1 and 2 were planned for the ground level, with zone 3 located approximately 400 mm above and zones 4 and 5 located a further 400 mm above zone 3. It was also anticipated by the LED that the difference in height would enable students in each setting to maintain focus on the learning activities rather than be distracted by students in otherwise close proximity. This became a critical concept in the design, to ensure that students experienced a fundamental awareness of their immediate surroundings—the group around the table and the resources in close proximity—with a simultaneous sense of space and separation from other student groups. The LED described the spatial and educational objective for this architectural gesture:

> *What I thought we could do with the steps was create a sense of separation ... my presumption all along was that if we could get people to be, in a sense out of kilter spatially, they would be primarily aware of their own group and themselves in that group and have a very secondary awareness of everybody else in the room.* (LED)

The multiple platforms provided a unique spatial and experiential identity for the Learning Lab, setting it apart from any other collaborative learning space at the time. The observations validated the LED's objective of providing separation that would enhance the ability of students to focus on activities within their zone. It was apparent that many students often opted to view their local LCD screens rather than the large-format projection wall, indicating a comfort in focusing within the parameters of the zone. Observations of teachers interacting with students indicated highly focused conversations taking place with little apparent distraction from neighbouring groups. Students were focused on the teacher and vice versa.

Although multiple platforms have provided a novel solution in the Learning Lab, it does not necessarily transpire that platforms should be designed into what would otherwise be flat floor spaces. This feature works in the Learning Lab because the redundant volume afforded the opportunity for it. If these conditions presented themselves within a campus building, then multiple platforms would be worth considering and testing in design.

7.5.4 Clusters of Technology Available to Students in Each Zone

The LED brought insights from previous design experience to the design of the Learning Lab, including knowledge of audio visual systems. For example, there was some doubt as to whether or not the group-based data projectors and projection screens installed in the large CTLC classrooms at the University of Queensland were the ideal solution for encouraging group-based use of technology. Instead, the technology solution in the Learning Lab included the use of LCD screens. The TM was cognisant that the Learning Lab was a learning space like no other at the University of Melbourne, proclaiming:

> *It was [our] job to understand first and foremost what the educational designers were wanting, and to provide multiple ways, multiple solutions, not to come up with any hard and fast option, and to totally suspend their established view of how things should be done and to totally suspend a strict adherence to the university's design guidelines. But just to let go of all that and to focus on, to keep reminding themselves that it was not a lecture theatre, it was not a seminar room, it was something very different.* (TM)

The fundamental uniqueness of the technological capability of the room was that the students in each zone were granted access to the same audio visual equipment as the teacher. That is, each zone incorporated desktop computers that could project to the local LCD screen. Desktop computers were networked to the faculty intranet as well as the internet, enabling students to access web-based curriculum activities or research information. Students had access to a wall-mounted whiteboard, where as a group they could test ideas, make notes, respond to problems and so on. Further, each zone contained a digital document camera, which enabled students to record data and experiments and capture them on the LCD screen. Another feature of the room, although not witnessed as being used during observations in the Learning Lab, was the demonstration bench at which 'dry' experiments could be conducted by the teacher and, via an overhead camera, viewed by students at each of the LCD screens around the room.

The synchronicity between the teacher's workstation and student zones was a defining feature of the technology, which was not immediately apparent when viewing the room. The LCD screens could be operated locally by students, rendering it possible to have five different activities on display around the room at any one time. If the teacher viewed a group working on something interesting the teacher could easily display that group's work on all LCD screens to initiate a discussion on a point of interest. Alternatively, student presentations could be conducted locally in one zone, but be displayed on the LCD screens throughout the space. The interconnectivity of the LCD screens enhanced the ability of students to share their work and interact with each other, and for teachers to interact with students to reinforce key concepts.

The technology has enhanced the opportunities for student-centred learning to be implemented, presenting a wider range of possible activities to be implemented by the teacher.

7.5.5 Teaching Practice in the Learning Lab

The teaching practice that each academic brings to a teaching encounter can vary considerably, depending on the subject, the cohort and the time of semester, refer Figure 132. In the Learning Lab, all observed students were studying first year chemistry and the observations were all undertaken in Semester 1.

During design it was anticipated that the majority of activity in the Learning Lab would be student centred and collaborative; that students would be doing the majority of work during the tutorials. The teachers explained that the tutorials to be observed involved responding to a series of chemistry problems. The author expected that teachers would introduce the tutorial with some instruction and explanation of the chemistry

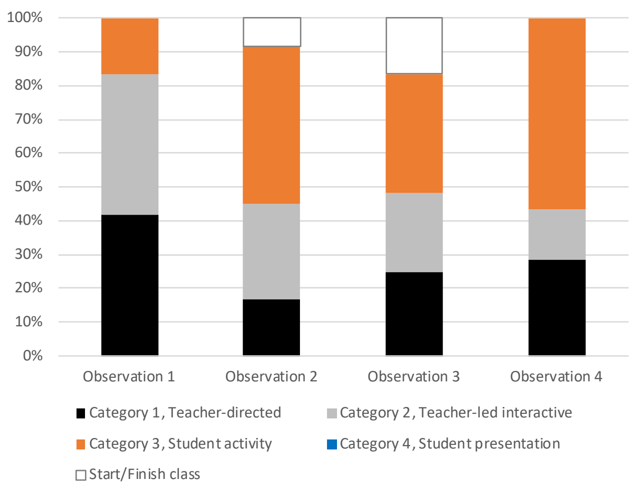


Figure 132: Teaching & learning categories across all observations

problems, with students then forming groups to work through the problems, followed by an interactive verification of responses with the teacher.

Of the 240 minutes of observed activity in the Learning Lab (4 x 60 minutes), it was disappointing to note that over half of the accumulative teaching and learning activities were either ‘teacher directed’ (didactic) or ‘teacher-led interactive’, where students were listening and sometimes responding to questions, refer Figure 132. ‘Student activity’ consumed 39% of observed time and 6% was attributed to waiting for the tutorial to start or decanting from the space. T2 and T4 conducted their tutorials with relatively high proportions of time allowing student activity (47% and 57% respectively), but T1 and T3 conducted tutorials that were distinctly teacher focused with only 17% and 35% of tutorial time enabling student activity.

It was also interesting to note that, despite the effort during design to conceptualise an educational framework of students working in groups of four and/or eight, the teachers did not make any attempt to, or express any interest in, applying this concept to practice. Despite the clear conceptual framework and time during design and construction to think about what this might mean in terms of implementation in the classroom, the chemistry academics did not appear to consider the structure of group work an important element:

> *We’re not rigorous. I think we’ll see what happens. I think we haven’t yet explored that—it’s a matter of time. It really is a matter of resources: of thinking, how could we engineer that? How would we come up with some activities that require four … the group of eight I don’t think really works anyway.* (T1)

This is contrary to the literature on collaborative learning, which recommends a structured approach that incorporates guiding the students on effective group practice as well as outlining the benefits of learning collaboratively (Bruffee, 1993; Gibbs, 1995; Jacques, 2000).

One of the reasons advanced by teachers T1 and T2 for not implementing the formal group structure of four or eight students was the position of the desktop computers and the perception that they formed a barrier across the table:

> *I mean that’s a barrier to talking across it actually ... If you want people to work in eights you’d really want to set it up in such a way that … they can talk across to one another.* (T1)

It's just easier for them to discuss in groups of four … and there're big computers in the middle of the tables so to talk over those computers could be a bit hard as well. (T2)

It is unclear if the teachers were aware that the computer screens were connected to brackets allowing them to be manoeuvred out of the way, which would have potentially increased communication across the table.

Another issue that emerged during the interviews and observations was that of 'content pressure', the time pressure stemming from teachers having to cover a set amount of content during a 1-hour tutorial. T2, T3 and T4 expressed this as a concern during the interviews, and during observations T2 in particular showed signs of concern (with facial expression) that she was running out of time:

Sometimes you run out of time, depending on the class, depending on how much you've got to explain. So I try to keep the [problems] that they should know until last. (T2)

I mean, once you start to get in [to] student discussion, you start to cut down the content you can cover. I think there's no doubt about that. (T3)

You just won't get through as much was, I think, the [concern of] some of the people who had taught for a long time, that we wouldn't cover the same things that we've always covered. The thing is you can cover things in different ways and students will actually learn by doing something themselves. You don't have to say it all. (T4)

Related to 'content pressure' was the constraint of the tutorial being limited to 1 hour. The extent of content to be covered in 1 hour compelled teachers towards teacher-centred instruction rather than student-centred activity, especially in light of the perception by some teachers that student-centred learning diminishes the extent of content that can be covered.

The timing of the tutorial in relation to the lecture may have increased the time that some teachers spent in teacher-directed or teacher-led interactive mode. T3 stated 'it's harder to give a tute at the start of the week than the end of the week, because they might not have actually covered it in lectures'. T4 was the only teacher whose tutorial was timetabled after the related lecture. She still conducted the first part of the tutorial didactically, but the remainder of the class was dominated by student activity interspersed with some discussion of answers to the chemistry problems. T1, T2 and T3 all provided a brief outline of key concepts to be explained in the pending lecture, but T2 was able to do this quite interactively, whereas T1 and T3 conducted mini-lectures.

Issues of content pressure, duration of the tutorial and timetabling may not have directly influenced the design of the Learning Lab. However, as a result of interviews with the teachers and observations of their learning encounters, these issues emerged as factors that have led to a prevalence of teacher-centred teaching rather than the student-centred learning experience that was anticipated during design. While the Learning Lab afforded the potential to enable student-centred, collaborative tutorial experiences, the observed episodes indicated that many teachers were yet to embrace the potential of the environment in their tutorial practice.

7.5.6 Has the Learning Lab Changed Teacher's Practice?

The teachers interviewed universally agreed that the Learning Lab had changed their teaching practices. T4 in particular expressed her frustration with tutoring in lecture theatres where she attempted to implement interactivity but found it too difficult because of the physical constraints of that setting. T4 explained that the Learning Lab had enabled her to teach in a more interactive way:

> *I reverted to my normal way of teaching as a teacher, which was far more interactive both with me, the students and the students with each other. You were able to let them do a bit of it themselves and find things out for themselves and then talk through their problems, which I think helps them to understand the concept a lot more, a lot more quickly anyhow.* (T4)

Other teachers expressed positive aspects of the teaching experience in the Learning Lab. There was a mutual sense of interacting more with students in the Learning Lab than in the previous lecture theatre environment, which in turn enabled teachers to develop a greater understanding of the student perspective:

> *It's more personal. You can sit there with a student, if you've noticed one student in the group who hasn't cottoned on you can actually sit there one-on-one and explain to that student one-on-one, what they're doing wrong.* (T2)

Some teachers acknowledged the value of the additional resources in the room and the positive effect this had on their teaching experience and the range of activities it presents for students:

It is new and interesting and therefore something to be explored, And I think … that gives you something to work with and I think that's good. I think it is making us think about other resources that we can bring into it because it enables us to … make use of not just the technology but the geography and the facilities in the room. (T1)

The space supports the fact that I like to get out and move around the students and talk to them. It gives me the chance to interact with them on an individual basis, and to spend even a brief period working with one student, and I value that. It also gives us the chance, and this is a collective thing, to do some useful activities that we otherwise couldn't do … we have access to some technology to look at movies and various things related to the way a chemical reaction occurs or structure of cells and that sort of thing. (T3)

T4 contended that the Learning Lab had positively influenced the way students understood chemistry. Students had greater access to teachers than in a lecture theatre. Through increased interactivity with teachers, students developed a deeper understanding of key chemistry concepts. T4 explained:

I think [the Learning Lab] makes a very big difference to the way the students understand and learn first year chemistry and I certainly enjoy teaching there … the general feeling from the students is that they enjoy coming to the room and they enjoy the comfort of the room and the accessibility of the staff to them in that room. I reverted to my normal way of teaching as a teacher, which was far more interactive both with me, the students and the students with each other. (T4)

There was a sense that the Learning Lab had synergistically resulted in teachers changing their teaching practice. This was partly because of the revised curriculum that specifically enabled students to become more interactive with the teacher in the classroom. Despite the positive sense of adapted teaching practice, teachers could continue to increase the extent of student activity and student-to-student interaction.

7.6 ALIGNMENT WITH THE EFFECTIVE TEACHING & LEARNING FRAMEWORK

How do these observations and insights align with each element of the Effective Teaching and Learning Framework? How has the Learning Lab enhanced the possibility for effective teaching and learning?

Each observation confirmed the ease with which teachers could move around the room to access each student at each table setting and engage with students individually or in small groups (Element 1). Meaningful discussions and interactions were evident. There was a support teacher in each class, ensuring that all students were able to seek assistance during the learning activities. Each table setting incorporated a suite of educational technologies, equivalent to technology accessed by the teacher. While student use of the full range of technologies was not observed, engagement with the digital screen, whiteboard and document camera was nonetheless possible.

Each teacher addressed the whole class from a social distance but was also observed engaging with groups at a personal distance and with individuals at an intimate distance (Element 2). Similarly, students were observed engaging with each other at personal and intimate distances. There was no need to manoeuvre furniture as all of the technological resources were contained within each group setting, that is, desktop computer, digital screen, whiteboard and document camera. Although the teachers did not officially instruct students to work in groups, the majority of students appeared to work in small groups to undertake each task, confirming a process of socially constructed learning.

It was evident that students engaged with the learning content and each other, as facilitated by each teacher (Element 4). In some instances, students utilised the desktop computers; at other times students engaged in small group discussion and note taking. In one class, students were provided with plastic model molecules to explore chemical particles in three dimensions. In another class, the teaching assistant conducted a chemical experiment under the digital document reader, which transmitted the visual experience to all digital screens around the room. Therefore, it was possible for students to engage with content in a variety of ways. It was less clear how students or teachers captured and shared content created in class. While the technology in the room enabled uploading and downloading of content, and the majority of students were observed to have brought their own laptop to class, there was little evidence of content sharing.

There was some evidence of teachers adapting their teaching approach in the classroom in response to their awareness of gaps in student knowledge (Element 5). The observations in the Learning Lab were all with first year chemistry students, for whom building foundation knowledge was critical. During the in-class activities, the teacher and teaching assistant visited each table setting to answer student questions. At the end of the activity, the teacher brought the whole class together to discuss the answers and reinforce critical concepts, especially focusing on aspects the teacher had detected as not being fully understood by the students.

Teachers and teaching assistants were observed providing timely and effective feedback to students (Element 6). They did this through discussion with students during the in-class activities. It was difficult for teachers to scan the room to view student progress, as students were not using the locally situated digital screens for their work in progress. When the teacher addressed the whole class in teacher-led interactive mode, students answered questions individually but were not required to present their findings in any formal 'presentation' manner. Despite the lack of observations of students using the digital screens in group mode or presenting to the class to seek feedback from the teacher, these activities were clearly possible and likely to occur in future episodes.

7.7 CONCLUSION

The affordances of the Learning Lab epitomise the characteristics and intentions of a NGLE. In contrast to the DILE, which was designed intentionally to be highly mobile and adaptive, the Learning Lab is fixed in its arrangement of furniture and technologies. However, the Learning Lab can be described as 'pedagogically flexible'. The setting enables a wide range of pedagogies, from didactic presentations to collaborative learning, PBL, peer-to-peer learning and independent learning. The activities possible in the room are limited only by the teacher's imagination: the technologies provide a portal to the world, enabling synchronous or asynchronous sharing of knowledge between students and teachers. With appropriate planning by teachers this space is a place where students and teachers can develop meaningful and enduring learning relationships.

The Learning Lab at the University of Melbourne represents a considerable investment in infrastructure and demonstrates a willingness on the part of the university to take a significant risk. As the LED stated:

> *there was a risk there that people would think it was just too bizarre and too challenging … It might become a room that people then tried to teach in very traditional ways just because they were uncomfortable doing anything else. So we might have had this really unique space being used in a really bad way. That was a danger.* (LED).

The Learning Lab is evidently enabling effective teaching and learning to take place, despite observations that the School of Chemistry was not using the classroom entirely as educationally intended or anticipated during design. The misalignment between the educational concept of collaborative learning for four or eight people established during design and the absence of any attempt by teachers to implement this concept, does not appear to have diminished the classroom's effectivess for enabling collaborative learning.

While the physical features of the classroom support an effective teaching and learning process, it is apparent that operational issues such as content pressure and duration of the class can be a determining factor in the successful application of effective teaching and learning. Longer classes and expanded time on task may strengthen the potential for students to become more deeply immersed in the learning process.

Chapter 8 - Case Study 4: The Electrical Engineering PBL Studios, Victoria University

8.0 INTRODUCTION

The EE precinct at Victoria University, Melbourne, housed a collection of learning spaces and facilities designed for engineering undergraduates to become immersed in a student-centred learning experience, pedagogically described as PBL. The precinct was unique because it placed students at the heart of the facility, situated in studios where student groups could study, collaborate and meet teachers throughout the semester. Students were afforded responsibility and autonomy not normally associated with undergraduate programs.

The EE precinct did not conform to the class structures employed in the previous case studies presented in this thesis. Instead of formal timetabled classes in which observations could be made, student groups arranged a weekly time for the teacher, referred to as their 'supervisor', to visit their studio. There were almost 30 individual studios and supervisor meetings occurred at different times of the day, every day. The methodology for this evaluation thus evolved in response to the operational aspects of the environment.

The participants in the evaluation included: 1) the architect involved in the design and procurement process; 2) two teachers (T1 & T2) and a laboratory technician who taught in the PBL program; and 3) four students who used the PBL precinct. T1 was the primary stakeholder, but also supervised third year PBL teams. T2 coordinated the first year PBL practice subject and supervised a number of first year PBL teams. The laboratory technician supervised students in two engineering laboratories and managed the storeroom where students purchase materials for their PBL projects.

As with the previous case studies, the architect and staff were interviewed in depth. However, the observation of students consulting with their supervisor amounted to little more than watching a passive meeting take place. This differed significantly from other case studies where students were observed actively using a single classroom. Instead, the engineering students at Victoria University had access to multiple learning spaces throughout the week, making it difficult to observe students in any one place. Rather than literally following students around the engineering precinct, student volunteers were asked to keep a diary for one day, recording how they used and for how long they used the various learning spaces within the engineering PBL precinct.

For the first two years of the PBL program the school also undertook its own in-depth evaluation of the EE PBL precinct—including seeking feedback—enabling fine tuning of the curriculum approach and identifying issues pertaining to the physical infrastructure. The report emanating from that evaluation, along with numerous academic papers published by academics in the PBL program at Victoria University, collectively informed this study.

8.1 UNIVERSITY CONTEXT

The EE PBL precinct was located on floors 4 and 7 of Building D at the Footscray Park campus (see Figure 133). This 1960s brick and glass Internationalist-style building was typically institutional and devoid of ornamentation. The spine of the building was oriented north–south, with the eastern facade overlooking the Western Courtyard.

The EE PBL precinct was developed in three stages: the first year precinct on Level 7 was completed in 2006; and the second year precinct to the southern end of Level 7 was completed in 2007. At the time of data collection, the third and fourth year precincts were under construction. Each precinct is similar, although the common room in the first year precinct is shared by all year levels, and a variety of laboratories was distributed among the precincts, relevant to their year level. This study focused only on the first and second year precinct on Level 7, refer Figures 134 & 135.

Figure 133: Location of the Engineering PBL precinct on the Victoria University Footscray campus

8.2 ORIGINS OF THE ELECTRICAL ENGINEERING PBL PRECINCT

8.2.1 Catalyst

In 2005 Victoria University embarked on an ambitious endeavour to make '25% learning in the workplace and community a universal feature of VU [Victoria University] courses' (Harman, 2008–2016). The School of Electrical Engineering responded to this mandate via the introduction of PBL. Concern over poor retention rates (Stojcevski & Veljanovski, 2007) and engineering industry feedback that claimed Victoria University graduates were lacking certain important skills further provided the impetus to introduce PBL.

Engineers Australia, the accrediting agency for engineering degree programs in Australia, published a manifest of graduate attributes (Bradley, 2006), explicitly stating the expectation of graduates having skills such as:

> *the ability to communicate effectively ... undertake problem identification, formulation and solution ... and function effectively as an individual, and in multidisciplinary and multicultural teams, with the capacity to be an effective team member.* (Bradley, 2006)

In response to the need for these graduate attributes, academics in the School of Electrical Engineering sought to change the curriculum to introduce PBL.

Introduction of PBL was accompanied by recognition that the School of Electrical Engineering facilities would require refurbishment, to create environments appropriate for the collaborative problem-solving activities associated with PBL. The architect commissioned to design the new environment initially conceptualised 'classroom' environments with break-out rooms for group work. The idea was that a teacher would manage a class, incorporating the ability for student groups to break off into adjacent rooms to work for a period of time, before returning to the classroom for central discussion.

Aalborg University in Denmark was founded upon the principles of PBL. A PBL consultant from Aalborg University visited Victoria University to provide advice on developing the curriculum. In doing so, the consultant provided advice on the most suitable design response. Rather than the 'break-out room' concept, he advocated the allocation of meeting rooms to student groups for an entire semester. The Victoria University environment was not conducive to fully enclosed meeting rooms, which would have placed significant demand on the building's air conditioning systems. However, a design for small 'studios'—with partitions to a maximum of 1,600 mm high—resolved the air conditioning issue and enabled a concept for dedicated PBL group study spaces to be pursued.

8.2.2 Curriculum change

Prior to the implementation of PBL, the Bachelor of Electrical Engineering program was delivered as a traditional teacher-centred model of lectures and tutorials. The student-centred model of PBL involved subjects being integrated with authentic engineering problems and students working in small groups to solve them (Stojcevski & Veljanovski, 2007). Fifty percent of the curriculum at each year level was attributed to 'PBL engineering practice' with the other fifty percent being dedicated to fundamental maths, science and related technical subjects, which were delivered in the traditional lecture and laboratory mode. PBL engineering practice was further supported by non-engineering staff who provided guidance on topics such as language and communication, writing skills and project management (Stojcevski & Veljanovski, 2007).

The centrepiece of the curriculum was the 'problem', which derived from an extensive, collaborative process between academic year-level coordinators, a dedicated PBL liaison officer and the laboratory technician. The liaison officer reported on meetings with industry partners, identifying potential topics around which a PBL assignment could be created. The laboratory technician played a key role in conceptualising the resources to which students would require access for each potential topic. If, for example, a particular topic required access to expensive equipment or involved students purchasing expensive materials, the laboratory technician would bring this to the attention of the planning team.

The PBL assignments for each year level and each semester were planned collaboratively and then communicated to the teachers, who were then allocated PBL groups to supervise. Each year level undertook the same assignment, revealing to students an inherent characteristic of engineering practice, that a problem could be approached and resolved in multiple ways. The schedule of generic topics to cover in a particular semester was planned in response to the PBL assignment, ensuring students were supported with appropriate project management guidance.

The structure of the PBL subject was for students to allocate at least 10 hours per week to formal activities such as meeting with a supervisor, online learning, laboratory work and lecture topics to support the PBL experience (see Table 19). Time allocated to working on the assignment with the team was in addition to that commitment.

Table 19: *Breakdown of the PBL & Engineering Practice unit (Ozansoy, year unknown)*

Module/Activity	**Weekly Time Allocation (hours)**
Team-Supervisor meeting	1
Online teaching and learning (WebCT)	1
Language and Communications lecture	1
Laboratory work	3
Project Management lecture	1
Engineering Practice, PBL skills module	1
Maths workshop	2
TOTAL	**10**

Figure 134: Electrical Engineering 1st and 2nd Year PBL Precinct, Building D, Level 7
Source: Blomquist Wark

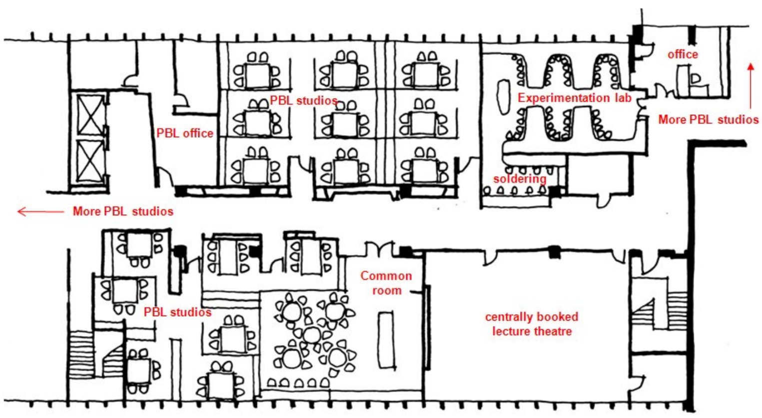


Figure 135: Furniture plan of part of the PBL precinct, Building D, Level 7
Source: Jo Dane

8.3 PEDAGOGY AND DESIGN

8.3.1 Architect's response

The PBL subject structure outlined in Table 19 suggested a range of activities that required students to move between different learning spaces according to the activity, resulting in the emergence of two elements in the design of the PBL studio concept: 1) self-contained studios; and 2) support spaces including the common room, laboratories and access to lecture rooms. According to the architect:

> *one of the driving forces of this was to actually move away from the students visiting the lecturer and instead the lecturer comes and visits the students ... and that's where the interaction would happen.* (Architect)

The second year EE precinct encompassed approximately 600 m2 in area, incorporating student work areas, a common room, laboratory, a small lecture room and staff offices, refer Figures 136- 140. Laboratories and the common room were located in convenient proximity to the studios, enabling students to oscillate between spaces throughout their project.

Figure 136: PBL Studio Cabins Level 7
Source: Victoria University

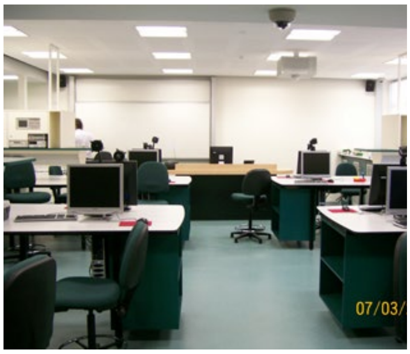


Figure 137: Experimentation Laboratory
Source: Author

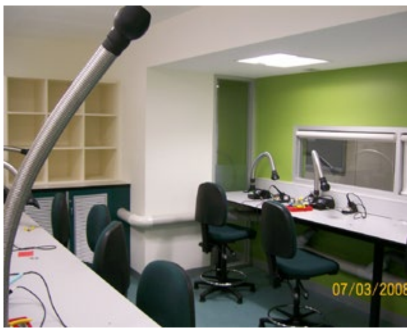


Figure 138: Soldering Workshop
Source: Author

The floor was carpeted in the university standard, except for the common room and laboratories, which were finished in resilient vinyl. The walls and ceilings were simply painted, although some colour was used to differentiate the area from other academic zones. Glass partitions provided views into student areas and laboratories, contributing to a sense of activity and engagement in the discipline. Opportunity existed for student work to be displayed in glass cabinets along the central corridor; however at the time of data collection they were not being well utilised.

The studio partitions were designed at 1,600 mm high to ensure students had visual privacy when they were working at the meeting table, but as the architect described, ‘when you stand up you can see over the top so you can see if there’re students around’ (Figure 136). This contributed to a sense of security and collegiality, encouraging students to build social networks among student groups. Social activities that students undertook while in the studio precinct were not discouraged, acknowledging that being socially connected to each other was a contributing factor in student retention.

Safety and security was a major concern for the institution as it was considered unconventional to allow students to take ownership of their own space without supervision by a staff member. Security of personal belongings was supported through the provision of lockers in each studio, one for every student. At a broader level, studio zones could only be accessed by students authorised to enter that particular zone, using an electronic fob to unlock the electronic door.

Figure 139: Common Room Presentation Desk
Source: Author

Figure 140: Common Room in the second year precinct
Source: Author

The architectural response was constrained by a modest budget and the infrastructure limitations of the building; for example the low ceiling height. Consequently, the design relied on a functional sensibility rather than aesthetic adventure. Use of glass partitions and windows from the central circulation space into studios and laboratories provided glimpses of student activity and productivity. Glass display cabinets in the common room afforded the opportunity to display student work and engineering artefacts. While students could do more to brand the space as their own, or accentuate the precinct as an 'engineering precinct', the environment responded effectively to the pedagogical imperatives.

8.3.2 Design features

The singular defining feature of the EE PBL precinct was that students had their own 'studios', which were allocated to them for a semester (Figure 136). Students worked together in groups of five or six on assigned problems that continued either for a few weeks or an entire semester. As further support to student learning the precinct also contained a common room with kitchen and presentation facilities, an 'experimentation laboratory' (Figure 137) and a soldering laboratory (Figure 138). Both laboratories operated with technical support for students. The supervisors visited the student groups at scheduled times during the week, leaving students to responsibly manage their time and look after the studio spaces.

8.3.3 Studios

The PBL precinct offered 16 first year studios, providing a capacity of approximately 80 students, and 13 second year studios, providing a capacity of approximately 65 students. Each studio was approximately 14m2 and formed by 1,600-mm-high demountable partitions (Figure 135). Inside the studio was a square or rectangular table and six chairs, as well as six lockers for students to secure their belongings. The partition surfaces combines a whiteboard and pin board. A desktop computer was positioned on the table, although the precinct was wirelessly enabled and students were encouraged to bring their own laptops.

Studios were clustered together in groups of up to six and access to each cluster was via a security swipe card. Only students allocated to that cluster could access that area. As the partitions did not extend to the ceiling, the occupants of adjacent studios could be heard, contributing to a sense of belonging to a larger community. Students could access and use the studios at any time during the operational hours of the building.

8.3.4 The Common Room

The common room was a shared facility for EE students across all year levels. It contained several round tables, seating up to 30 people (Figure 140). A continuous bench located under the windows contained two sinks, a microwave an under-bench refrigerator at one end, and four desktop computers for general access at the other. A large presentation podium was located at the southern end of the common room, with access to a whiteboard and data projection facilities (Figure 139).

The common room served a variety of purposes including students' storage, hospitality zone, access to computers and staff planning meetings. It was also where students presented their PBL assignments to their colleagues and industry partners. In addition to these activities, some staff members observed students using the facilities to watch movies, make movies and play computer games. These socially oriented activities were not been discouraged and appear to contribute to the sense of community that was evident throughout the precinct.

8.3.5 Laboratories

There were two types of laboratories in the second year precinct: an 'experimental laboratory' and a 'soldering workshop'. The experimental laboratory was a larger space with a capacity of up to 30 students (Figure 137). It was used by staff and students to access specialist software and conduct simulations. Some timetabled activities took place, with the teacher using a central demonstration workstation to project material to the wall. When not timetabled, students could use the laboratory on demand. A laboratory technician was located in an adjacent office, providing technical support to the students as well as managing the storeroom where students could purchase materials relevant to their PBL assignments. The soldering workshop was accessed via the experimental laboratory and contained a workbench and specialist soldering equipment (Figure 138). Up to six students at a time could work in the workshop.

OBSERVATIONS:

- Pre-observations
- Osbervation 1
- Adapted Methodology
- Student Diaries 1 - 4

PRE-OBSERVATIONS

8.4 OBSERVATIONS

8.4.1 Teachers' Intentions for Class to be Observed (Pre-observation)

Students arranged consultation with their assigned supervisor for 1 hour per week. This became an intensive, focused session where the supervisor discussed progress, issues, methodology and formatting of the assignment. Importantly, these meetings occurred in the PBL studios, in the domain of the student. It cannot be overstated how unusual it was for students to 'host' their supervisor, rather than for students to attend classrooms that were typically the domain of the teacher. This situation was deliberately orchestrated to emphasise the student's responsibility in their learning experience. The supervisor was there to ensure students were progressing and to assist with strategies to resolve particular aspects of the assignment. As T2 declared:

> *we prefer not to provide them with answers to the questions ... I usually tell them I will not be spoon-feeding them the results and answers, but I do help them quite a bit to guide them to the solution.* (T2)

At the end of the PBL cycle, a program of presentations was conducted in the common room. The size of the room did not enable all groups to be accommodated simultaneously. Consequently, four or five PBL groups presented to each other. The relevant supervisors attended and where possible, a representative from industry attended also. Every component of the PBL curriculum was planned to equip students with appropriate skills to effectively work in groups, manage the PBL assignment, communicate clearly and solve problems.

OBSERVATION 1

8.4.2 Observation 1: T2, Group Consultation

A group of first year students was selected for observation of their scheduled consultation with T2. There were five students plus T2 in the studio (Figures 141 and 142). Whether it was because of the small size of the studio setting or the apparent intensity of relationship between T2 and the students, the author immediately felt like an intruder. This was acutely different from a classroom scenario, where the observer could recede into the background and become a passive participant. Because of the physical limitations of the studio it was impossible for the author to act as a passive participant; consequently the author opted to observe proceedings from the corridor space, viewing through glass partitions. The meeting ensued like most meetings, with participants around a table having a discussion. At several points throughout the meeting, T2 utilised the whiteboard to make notes and demonstrate key points. There was no movement by the participants beyond the studio, highlighting for the first time that the observational methodology implemented in the previous case studies was not going to effectively apply to this case study.

8.4.3 Observation 2: Presentation

The group that was observed conducting the meeting with their supervisor was also observed presenting their PBL findings. The presentation took place in the common room and was attended by 18 students, five supervisors and the author. The group of six students presented from the presentation desk, utilising projection equipment to demonstrate their work. The presentation commenced at 2:05 pm and ended at 2:30 pm. Group members took turns to present a component of the PBL response. The audience was sitting casually around the round tables. At the end of the presentation the students responded to questions from academic staff.

Figure 141: PBL studio consultation with students
Source: Author

Figure 142: PBL studio consultation with students
Source: Author

8.5 ADAPTED METHODOLOGY

As described in Chapter 4, the methodology for the EE PBL precinct at Victoria University demanded modification as it did not represent classrooms in the conventional sense. With the objective of understanding how students used the entire precinct, students were asked to complete a written diary for 1 day, using the template in Figure 142. This involved completing a timeline and responding to the following questions:

- What task were you doing? (Relating specifically to your engineering PBL coursework)
- Where were you located? (Studio cabins, common room, lecture theatre, laboratory, or other) (please specify)
- Why did you locate yourself there? (As opposed to somewhere else?)
- Who was with you? (Fellow group members, supervisor, other students…)
- Who or what else did you interact with? (What resources did you utilise? Computers, lab equipment, other (please specify), supervisor, lab tech?)

While only a small number of diary responses was received the data obtained provided a sense of how students moved between spaces, depending on their needs and the demands of their PBL project.

8.5.1 Student Diaries

The diary responses have been reformatted in the following tables 20- 23, however the blue italicised activity descriptions are verbatim responses from the student.

STUDENT DIARY TEMPLATE

PBL ENGINEERING STUDIO, STUDENT DIARY **DATE OF COMPLETION:** **PLEASE COMPLETE BY FRIDAY 26TH SEPTEMBER 2008**

Time	What task were you doing?	Where were you located?	Why did you locate yourself there?	Who was with you?	Who or what else did you interact with?
	Relating specifically to your Engineering PBL coursework.	Studio cabins, common room, lecture theatre, laboratory, or other (please specify)	As opposed to other places you could have gone to study?	Fellow group members, supervisor, other students…	What resources did you utilise? Computers, lab equipment, other (please specify), supervisor, lab tech?
8am					
8:15					
8:30					
8:45					
9am					
9:15					
9:30					
9:45					
10am					
10:15					
10:30					
10:45					
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12:45					
1pm					
1:15					
1:30					
1:45					
2pm					
2:15					
2:30					
2:45					

This project is voluntary. I understand I can withdraw at any time. I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any research publications and presentations.

Upon completion, please return using reply paid envelope, or deliver to: Office for PBL, Building D, Level 3, Room D3.18.
New Generation Learning Environments for Higher Education
Victoria University Ethics Project No. HRETH 07/248

Figure 143: PBL Student Diary template
Source: Author

STUDENT DIARY 1

Table 20:

Diary 1: Student S1

TIME	LOCATION	ACTIVITY
8:45am	PBL Common Room Why: *easy to find students*	Task: *Lend PBL 'PIC board' to second year students* With whom: *Second year students* Resources used: unspecified
11:00am	PBL Soldering Lab Why: *students were working there*	Task: *Get PBL 'PIC board' from second year students* With whom: *Second year students* Resources used: unspecified
11:15 am- 12:00pm	PBL studio Why: *allocated room*	Task: *Programming the PIC for the web page* With whom: unspecified Resources used: unspecified
1:00 - 2:00pm	PBL studio Why: *allocated room*	Task: *PBL supervisor meeting* With whom: *Team members (3 team members) & supervisor* Resources used: *Computers for showing code, whiteboard & PIC programming board*
2:00 - 3:00pm	PBL studio Why: *allocated room*	Task: *PBL team meeting designing circult layout, coding etc* With whom: *team members* Resources used: *Computers for showing code, whiteboard & PIC programming board*
3:00 - 4:30pm	PBL Soldering Lab Why: *has all the lab equipment*	Task: *Went to Soldering Lab to test current sensor* With whom: *by myself* Resources used: *lab equipment, multimedia, 'CRO' power supply and computers to check data sheet.*
4:30pm	Went home to continue project work	

STUDENT DIARY 2

Table 21:

Diary 2: Student S2

TIME	LOCATION	ACTIVITY
9:15- 10:15am	Lecture room D5.31 Why:	Task: *Attending lecture helpful for PBL project* With whom: unspecified Resources used: unspecified
11:00am- 12:00pm	Lecture theatre, G470 (different building) Why:	Task: *Lecture for PBL project* With whom: unspecified Resources used: unspecified
12:00- 1:00pm	Lecture theatre, D7.33 Why:	Task: *Lecture for PBL project* With whom: unspecified Resources used: unspecified
1:00 - 2:00pm	PBL studio Why: *resources available*	Task: *PBL team meeting with supervisor* With whom: *team of 6 and supervisor* Resources used: *computer for excel and word documentation*
2:00 - 6:00pm	PBL studio Why: *easy access to PC, quiet environment, away from distractions*	Task: *extra PBL, individual work* With whom: *with 2 team/group members* Resources used: *lab equipments and computer*
6:00 - 9:00pm	Soldering Lab Why: *all equipment available, all tools available*	Task: *working on PBL project: Soldering and preparing circuit board* With whom: *lab tech for help* Resources used: *lab technician was called at all times; electriconic circuit multimeter; soldering iron.*

STUDENT DIARY 3

Table 22:

Diary 3: Student S3

TIME	LOCATION	ACTIVITY
9:00- 11:00am	Unspecified	Task: *1st Lecture of the day* With whom: unspecified Resources used: unspecified
11:00am- 12:30pm	PBL Studio (D714) Why: *set place*	Task: *meeting* With whom: *fellow team members* Resources used: *my laptop, other people in the room, as I saw them*
12:30- 1:00pm	PBL studio Why: *chatted to friends, as I waited for class*	Task: *Waited for lab* With whom: *other students, team mates, Daniel* Resources used: *my laptop, other people in the room, as I saw them*
1:00 - 3:00pm	Experimental Lab Why: *set through timetable*	Task: *Lab* With whom: *Daniel (lab partner)* Resources used: *Anyone on the trip to the room & ppl in the room*
3:00 - 3:30pm	Cafeteria Why: *food*	Task: *Lunch* With whom: *Daniel / Vinnie* Resources used: *Daniel / Vinnie*
3:30 - 6:45pm	D717 (not allocated PBL studio) Why: *it's a very quiet room, D714 was too noisy*	Task: *Study* With whom: *Andrew / Vinnie* Resources used: *Anyone online, ppl via email, my laptop*
6:45pm	Went home to continue project work Why: *Got hungry, cafe shuts down, otherwise would stay & eat for a couple more hours*	

STUDENT DIARY 4

Table 23:

Diary 4: Student S4

TIME	LOCATION	ACTIVITY
11:00am- 12:15pm	PBL studio Why: *This is the room given to us to do our work.*	Task: *Team meeting* With whom: *with team meetings* Resources used: *computer, simulation programs*
12:15- 2:15pm	Experimental lab and PBL Studio Why: *Equipments are available to carry out all our work*	Task: *Work on simulation* With whom: *team members* Resources used: *computer, simulation programs*
4:00 - 5:30pm	PBL studio Why: *available room*	Task: *research work* With whom: *myself* Resources used: *access to internet and computer*

DISCUSSION

8.6 DISCUSSION

The PBL precinct was evidently a NGLE where students were required to take responsibility for their learning experience. The students' supervisors did not patrol the environment to enforce the learning process; it was each student's responsibility to manage their group dynamics, manage the evolution of their project, manage their time and complete their project. Supervisors and the laboratory technician provided support and guidance, but took care not to provide direct answers to students. The physical environment was designed to support this endeavour, providing dedicated spaces for students to work intensively for long periods and collaboratively. The close proximity of the laboratories, common room and, importantly, other students, contributed to a strong sense of collegiality and community in the precinct.

There was a crucial, synergistic relationship between the various elements of the PBL precinct whereby students moved backwards and forwards from the PBL studio several times a day and week. The studios provided a central point of contact for students where they could store their belongings and materials, conduct meetings and simply hang out between timetabled events (refer Figure 144). The PBL problem was central to everything that occurred in the precinct: timetabled lectures were directly related to skills students required to manage their project; laboratory sessions and resources were planned within the context of PBL assignments; and studios provided a place for students to meet, plan, discuss and work on the PBL project. The notion of collaboration worked as a series of individual tasks that developed as a result of the team interactions; each student undertaking their task, which as then shared with the group members, enabling the next level of planning and project to progress. In this sense students evidently met as a group several times a week, but did not continually occupy studios at the same time. Students undertook their individual tasks from home, in the laboratory, in the library or in the studio; they not only communicated with each other face to face, but also electronically via the online learning platform, email or telephone. Students worked in the studio individually, in small groups and occasionally as a whole group.

The supervisor's role in the precinct was to pave the way for students to undertake their PBL projects, not to lead or direct. The supervisors' offices were located on another floor in the building, in an environment that was office based as opposed to a 'learning' environment'. T2 expressed that students did not visit supervisors in their office. Apart from the weekly scheduled meeting in the studio, any other contact between supervisor and students occurred via the online environment. Supervisors were expected to spend time each work communicating with students through this medium, answering questions or guiding students towards appropriate resources.

The laboratory technician was a crucial ally in the PBL experience. He was not a supervisor in an official capacity but was cognisant of the assignments and required resources, and was similarly committed to enabling students to resolve issues for themselves. Like the supervisor, the laboratory technician paved the way for student learning by encouraging students to figure problems out for themselves as much as possible, but would provide technical assistance in the laboratories if students required it.

The School of Electrical Engineering PBL precinct at Victoria University was developed in response to the objective of solving real-life engineering problems, as well as improving generic skills such as project management and the ability to work in teams. The singular defining outcome of the precinct's organisation has been the dismantling of the relational authority that conventionally exists between teacher and student. In most learning precincts it is the students who are invited (via the timetable) to attend classes governed by the teacher; in the PBL precinct at Victoria University it was the teachers who negotiated to visit students for scheduled meetings. Even the laboratories, where students are traditionally closely supervised, were designed to 'allow students to construct and test electronic and mechanical projects without continuous

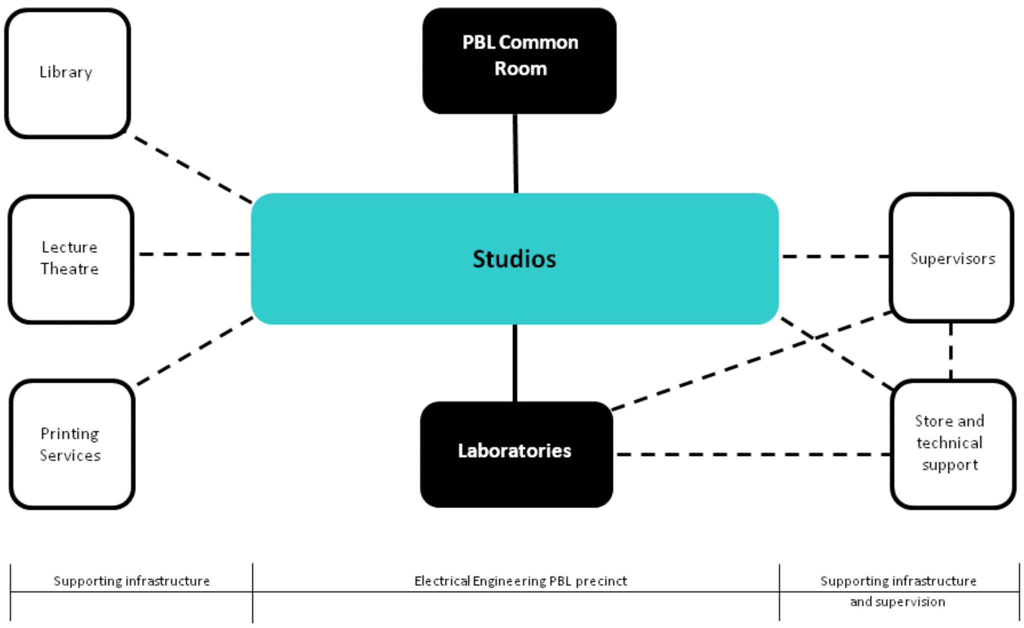

Figure 144: PBL Precinct Spatial Structure
Source: Author

supervision' (A. Stojcevski, Bigger, S., Gabb, R., Dane, J., 2009, p. 53). The physical environment was designed to encourage student independence from the teacher, while at the same time promoting team-based learning within small communities of learners.

The advice of the Aalborg University consultant to design the precinct with a multitude of studios for student groups to occupy longitudinally was undoubtedly a fortuitous intervention, enabling the PBL objectives to be realised. In contrast, at the School of Architectural, Civil and Mechanical Engineering, which shifted to a classroom-based environment to practice its version of PBL, it was observed by Stojcevski et al. that "staff members that teach in this space were more likely to slip into instructor mode and the students demonstrated less signs of ownership of the space" (2009, p. 59). Providing a studio space that students can use as a home base for the semester appears to have been pivotal not only in promoting learning independence and group work, but also contributing to a strong sense of community. Serious project work is occasionally relieved by social interaction and fun, perhaps with increasing blurring of these boundaries.

The imperatives of the university to demonstrate positive outcomes of their significant investment in shifting to a new curriculum and, to a lesser degree, a new physical environment led researchers in the Faculty of Health, Science and Engineering to conduct a comprehensive evaluation of the student PBL experience (Keating & Gabb, 2007). Surveys, focus groups and interviews with students, as well as a review of student results were undertaken three times throughout the first year of implementation. This process provided valuable feedback on positive and negative aspects of the curriculum, organisation and the physical environment.

Observations, descriptions from teachers and published papers have collectively provided a sense that the semester-long occupation of studios has made it possible for students to collaborate with peers, increase time on task, develop relationships with their colleagues and develop characteristics of independent learners that increase the likelihood of students engaging deeply with the engineering discipline (Keating & Gabb, 2007; Stojcevski & Veljanovski, 2007). The absence of supervisors from the learning precinct, apart from the scheduled 1-hour meeting per week, encouraged students to take responsibility for their learning. This may not have been a comfortable or popular aspect of learning for all students, but it is expected the study discipline and work ethic that students developed in the PBL program—as well as their technical proficiency—will serve them well when they enter the work force.

8.7 ALIGNMENT WITH THE EFFECTIVE TEACHING & LEARNING FRAMEWORK

How do these observations and insights align with each element of the Effective Teaching and Learning Framework? How have the EE PBL studios enhanced the possibility for effective teaching and learning?

While the teacher ('supervisor') only meets with each PBL group for one hour per week, that hour appears to be critical for the teacher to understand the student perspective and build a meaningful relationship with that group (Element 1). Being able to focus intensively on one small group for one hour enables the teacher to ask a lot of questions and hear students discuss their PBL project in great detail. The meeting occurs within a designated meeting room, negating the need to move around the entire precinct. Students have access to all technologies and workshops in the precinct. In a reverse of conventional teacher-student relationships, students take ownership of the PBL studios and teachers are 'invited' by students to attend the weekly meetings.

Students undertaking their PBL projects interact with each other predominantly at a personal and intimate distances, due to the small size of the PBL 'studio' (Element 2). Similarly, the teacher interacts with each student group at a personal distance during the formal meetings, due to the size of the meeting rooms. Presentations to staff and other students occur at a social distance. Social construction of knowledge is implied by the intimacy of the PBL studios, where students work together in close proximity for long periods of time to complete their PBL projects.

The PBL studios are assigned to student groups for an entire semester. Students can access the studio at any time during semester, engendering a freedom not experienced in other types of NGLEs and enabling a deep approach to learning (Element 3). Students become highly independent as they are required to manage their PBL project in terms of time management, group management and project progression. Students can work together cooperatively or undertake different tasks simultaneously. They can immerse themselves in a deep engagement with the PBL process with the freedom to spend significant time on task.

Students evidently engage actively with their PBL project and with each other (Element 4). The PBL studio enables collaboration among groups, but students also have access to specialist workshops in which they can test concepts relevant to their project. Hypothesis and testing is a critical aspect of the PBL process and the precinct as a whole supports a high level of student activity.

Learning is particularly contextualised and relevant in the PBL precinct (Element 5). The problems undertaken by student groups are real-world problems, devised by teachers in consultation with industry partners. While students work at their own pace throughout the entire semester, the weekly meeting with each student group enables the teacher to remedy any gaps in student knowledge. Teachers were not encouraged to simply provide answers to student questions, but rather to point towards strategies for students to find the answers themselves.

Effective and timely feedback is provided by the teacher to each PBL group during each schedule weekly meeting (Element 6). The hour-long meeting allows for an intensive discussion on each PBL project with the teacher ensuring that the PBL group is making adequate progress to achieve completion. Students also receive feedback from workshop technicians, who provide support to students who are testing specific concepts in the laboratory. Formal feedback occurs at designated times during semester when multiple groups come together with teachers and industry partners to review project progress, culminating in a final presentation at the end of semester.

8.8 CONCLUSION

The likelihood of students achieving the objectives of the PBL program are increased through the provision of the EE PBL precinct. Not only do students have a studio they can call their own for a semester, they have convenient access to the laboratories for technical activities and a common room for access to kitchen and presentation facilities. While the architecture of the engineering PBL precinct is aesthetically lacklustre, the sense of community that prevails in the program is inspiring.

The physical environment supports the endeavour of encouraging students to collaboratively solve problems and develop learning independence. Students are learning to be less reliant on the supervisor as they develop effective research and time management practice. Without the precinct, students would be forced to meet in places such as the library, a computer laboratory, the cafeteria, or off campus: places that limit the activities they can engage in. Libraries are in high demand for collaborative spaces and computer facilities, often requiring students to queue for a setting to become available. Computer laboratories typically have a high density of computers that discourage group work. The cafeteria may enable some collaboration but lacks technical infrastructure. Off campus places, such as a student's home, may be suitable depending on the individual's situation and proximity to their PBL group, but negate the opportunity to develop a sense of community with other PBL groups. The PBL studio environment addresses the university's objectives for implementing PBL and in so doing enables students to actively engage in the discipline of Electrical Engineering in an effective and meaningful way.

Chapter 9: Case Study Analyses and Discussion

9.0 INTRODUCTION

Four examples of NGLEs, as defined in this study, were presented in Chapters 5–8. Each case study classroom or precinct is unique in that it was conceptualised by an educator who wished to implement student-centred learning, with the explicit objective of improving the quality of teaching and learning. The educators also recognised that their preferred teaching and learning approach could not be implemented within traditional classrooms such as lecture theatres, computer laboratories and tutorial rooms.

The purpose of evaluating these NGLEs has been to identify **how new generation learning environments in higher education have been conceptualised pedagogically, and designed physically, to enable effective teaching and learning.** And, in the context of the four case studies, to evaluate if the physical characteristics have made effective teaching and learning possible?

This chapter will discuss the case studies within two distinct tracts:

1) compare and contrast pedagogical intentions, design and observations

2) reflect upon the spatial features that contribute to NGLEs, through the lens of the Effective Teaching and Learning Spatial Framework.

9.1 COMPARISON OF CASE STUDY ENVIRONMENTS

The four case study NGLEs represent wide variation in the interpretation of learning spaces, especially considering that the common pedagogical objective in each case was to enable collaborative learning. The DILE at Deakin University and the Learning Lab at the University of Melbourne are single spaces, whereas the CTLC at the University of Queensland and the PBL Engineering Studios at Victoria University are precincts consisting of multiple spaces. Why were the NGLEs designed so differently despite having the common objective of enabling collaboration? This section will compare the pedagogical intentions and design outcomes underpinning each case study.

9.1.2 Pedagogical Intentions and Design Objectives

Each case study was conceptualised with the premise of enabling a specific student-centred pedagogical approach, such as collaborative learning, PBL and peer learning. At Deakin University, the primary academic stakeholder (T1) expressed her preferred collaborative teaching and learning approach, upon which the space was designed. T1 intended to promote student interactivity with the objective of simulating a typical workplace experience for multimedia students, which led to the zoning of different furniture settings. The speed of the design process (due to the active building contract at the time) resulted in T1, the facility manager and the architect making all of the design decisions, preventing a deeper discourse regarding use of the space among a broader group of academics.

At the CTLC at the University of Queensland, the architect expressed frustration that the university was requesting an entire facility to be dedicated to 'collaborative learning' but the university was unable to describe or communicate what this meant in terms of classroom design. The architects were required to present different design solutions, to which the academic committee could react, rather than a proactive brief that articulated the types of activities to be enabled in the environment. This is an important point, as convention for establishing an education design brief is to communicate the number and capacity of classrooms. Activities are not required to be articulated for lecture theatres, computer laboratories and tutorial rooms as they are inherently accepted and rarely challenged. The design of a NGLE cannot work in the same way. It is critical educationally to articulate the range of activities that must be enabled, such as being able to work in groups of four people, or that each group is to have access to a computer. It was not until after construction of the CTLC had commenced that the LED and AVM arrived at the University of Queensland and were subsequently able to provide clarity around intended teaching and learning behaviours. They, in turn, created an educational narrative for the various scenarios to be enabled in the small and large classrooms, which led to its distinctive modes of operation.

The same LED was able to exert his influence from an early stage of design for the Learning Lab at the University of Melbourne. He worked with key academics to develop an educational narrative, articulating the types of activities that would occur, such as how students would work in groups of four or eight, and how each group setting would have access to a wide range of resources. This description, or brief, enabled the architect to create an innovative design response to align with the educational objectives.

The engineering PBL studios at Victoria University were designed on a completely different premise, influenced by educators at Aalborg University who were informed by implementation of PBL in dedicated studio spaces at Aalborg. The creation of PBL studios was not a new concept, but required a new interpretation of the environments known to work well in another university. The educators from Aalborg and Victoria University were able to express how they wanted students to be able to study and work together, which enabled the architect to respond through careful planning.

The variation in design processes highlights the issues and opportunities in conceptualising something new. It reduces the fundamentalist design approach that can be associated with the procurement of traditional classrooms. Using an educational narrative and understanding the effective teaching and learning behaviours to be enacted in a NGLE, the following two key insights were considered critical to the design of the case study NGLEs:

1. the presence of educators who were able to articulate the teaching and learning narrative; and
2. the ability of the architects to reconceptualise the notion of the classroom, in response to the educational narrative provided by the academics.

9.2 COMPARISON OF OBSERVATIONS

The exploration of teacher intentions, followed by observations of the same teachers in class, presented a compelling story, demonstrating the variation in teaching and learning approaches to be accommodated in NGLEs. The variation in approach across the four case studies has revealed three distinct modes of teaching and learning, affording a multitude of flexibility:in the use of NGLEs. A mode in this sense refers to the structure of delivering a subject to a cohort of students:

1) multiple teachers teaching the same subject to a large cohort

2) teaching across different year levels of the same disciplinary course

3) teaching across different disciplinary courses

9.2.1 Multiple Teachers Teaching the Same Subject

The four observations of teaching and learning in the Learning Lab at the University of Melbourne involved four teachers teaching the same topic to first year chemistry students. Despite the same content being covered with the students, the different approaches of the teachers were significant, as represented in Table 24. The orange colour signifies student activity, as distinct from teacher-led (grey) and teacher-directed (black) interaction. With the overall educational objective of the Learning Lab enabling collaborative learning, it was expected that student activity (orange) would dominate the observations.

However, as Table 24 shows, the observation of student activity varied across the four teachers from 16% (T1) to 57% (T4). The student experience of the same topic, in the same subject, in the same classroom, was considerably different depending on who their allocated tutorial teacher was. Despite this scenario occurring every week, there was little evidence of teachers communicating with each other as to how they were going to facilitate each topic.

It is possible that the same four teachers would yield completely different observations in another topic, with different activities planned. Therefore, it must be acknowledged that the Learning Lab has enabled a wide variety of teaching and learning approaches, albeit dependent on the teacher as to their pedagogical intentions and how they facilitate use of the classroom. The Learning Lab enabled effective teaching and learning to take place across multiple classes taking the same subject.

Table 24
Summary of Teaching and Learning activities in the Learning Lab (multiple teachers teaching the same subject)

	% Class Time			
	T1	**T2**	**T3**	**T4**
Category 1, Teacher-directed	**42%**	**17%**	**25%**	**28%**
Category 2, Teacher-led interactive	**42%**	**28%**	**23%**	**15%**
Category 3, Student activity	**17%**	**47%**	**35%**	**57%**
Category 4, Student presentation	-	-	-	-
Start/Finish class	-	**8%**	**17%**	-

9.2.2 Teaching Across Different Year Levels in the Same Disciplinary Course

The three observations undertaken in the DILE at Deakin University included two first year learning encounters and one third year learning encounter, within the same multimedia course. A comparison between the first year and third year classroom experiences revealed distinctly different experiences appropriate to each year level, as shown in Table 25.

Table 25
Summary of Teaching and Learning activities in the DILE at Deakin University (different year levels in the same disciplinary course)

	% Class Time		
	T2 & T4 First Year	**T2 & T4 First Year**	**T3, Third Year**
Category 1, Teacher-directed	**8%**	**12%**	**-**
Category 2, Teacher-led interactive	**37%**	**8%**	**-**
Category 3, Student activity	**47%**	**67%**	**100%**
Category 4, Student presentation	**8%**	**13%**	**-**
Start/Finish class	-	-	-

The first year classes were carefully facilitated with some teacher-directed or teacher-led activity (grey & black), combined with specific activities for students to complete in class (orange) and a summary session at the end to provide feedback on student output (blue). The third year class was noticeably different in that the teacher was present but made no attempt to address the class as a whole. T3 was there to facilitate independent collaborative learning, which by his own acknowledgement, required that he provide a mentoring role rather than a teacher-centred role. The DILE classroom afforded teachers variety in their teaching and learning approaches, according to the maturity of each cohort, without the need to change the physical environment. The DILE enabled effective teaching and learning to talke place across different year levels in the same disciplinary course.

9.2.3 Teaching Across Different Disciplinary Courses

The observations undertaken in the CTLC at the University of Queensland presented even greater variation in teaching and learning approaches, across different disciplines and year levels, as demonstrated in Table 26. Each encounter incorporated over 50% student activity (orange) and in most cases minimal teacher-directed or teacher-led activity (grey & black).

The first year science and fifth year veterinary science subjects were all undertaken in the small CTLC classrooms. They incorporated a similar structure of minimal teacher-led or teacher-directed instruction (grey & black) with the majority of time spent on student activity (orange) or student presentation (blue). Did the similarity in educational structure result from the affordances of the room? Did these scenarios exemplify effective teaching and learning practice? Could these teaching and learning behaviours have been enacted in a traditional tutorial room or lecture theatre? In each class, teachers and students moved around the room and accessed the resources within the classroom; that is, computers, tables for collaboration and LCD screens for sharing output.

Table 26

Summary of Teaching and Learning in the CTLC at the University of Queensland (different year levels across different disciplinary courses)

	% Class Time				
	1st Year Science (T1 & T2)	**1st Year Science (T1 & T2)**	**5th Year Vet Science (T3)**	**1st Year Communication (T4)**	**3rd Year Human Health (T5)**
Category 1, Teacher-directed	**13%**	**4%**	**4%**	**33%**	**-**
Category 2, Teacher-led interactive	**4%**	**8%**	**4%**	**6%**	**-**
Category 3, Student activity	**67%**	**75%**	**54%**	**50%**	**100%**
Category 4, Student presentation	**8%**	**8%**	**33%**	**-**	**-**
Start/Finish class	**8%**	**4%**	**4%**	**11%**	**-**

The communication and human health subjects were held in the large CTLC classroom. T4 spent 33% of the time lecturing to the class (black), before facilitating student activities (orange). T4 also commented that because of the duration and size of the class, there was no opportunity for students to share findings with each other by presenting back to the whole class (blue). T5 afforded students the freedom to organise themselves into groups to undertake a longitudinal PBL project within the large CTLC classroom. T5's perspective was that the amenity within the large classroom provided a suitable environment for collaborative learning, and that students would develop independent learning regardless of whether or not T5 was present. However, it is interesting to note that T5 recognised the alignment of what he expected students to be doing with the physical environment that was available to them.

The common experience of each of the case study environments was the ease with which the observed varieties of teaching and learning were able to take place. There was almost no requirement to move furniture, and where this did occur, the mobility of tables and/or chairs ensured this was a quick and easy task. Students had access to all of the technologies in each classroom, and in many cases were viewed operating them. The majority of teachers facilitated student activity, fulfilling their intentions to practice student-centred learning.

9.2.4 Would the Observed Teaching and Learning Have Been Possible in Traditional Classrooms?

Could the teaching and learning episodes - observed within the NGLEs - have taken place within traditional classrooms such as lecture theatres, tutorial rooms or computer laboratories? Lecture theatres would have limited the ability for students to undertake collaborative tasks, especially using resources such as whiteboards and digital screens, which are rarely situated for student access. It is difficult to imagine how any of the observed classes could have effectively taken place in a lecture theatre. Computer laboratories would also have limited collaboration, but there would have been access to educational technologies in the form of desktop computers. Some of the observed classes did use desktop computers, but with an intentional ratio of 1:3, meaning that small groups of students were encouraged to share a computer. Tutorial rooms, as has already been discussed, would have afforded students the potential to move furniture around, to facilitate collaboration and perhaps even access to educational technologies. However, the high density of furniture typically located in tutorial rooms would have made it difficult to easily manoeuvre furniture. This in turn would have made it difficult for teachers to easily and equitably access all students, making it difficult to build meaningful relationships with students and providing timely feedback. While effective teaching and learning may have been possible, it would have been compromised.

As a result of analysing the variety of teaching and learning approaches within the case study environments, it is possible to conclude that effective teaching and learning was taking place within each of the NGLEs and that the same educational objectives would have been considerably compromised if delivered within a traditional classroom. The NGLEs demonstrated considerable flexibility in being able to meet the needs of various teachers within the same subject, across year levels and across different disciplinary courses.

9.3 THE EFFECTIVE TEACHING AND LEARNING SPATIAL FRAMEWORK

The Effective Teaching and Learning Framework described in Chapter 3 was generated following extensive interrogation of the literature relating specifically to 'effective teaching and learning', resulting in six essential elements (refer Table 1). The essential elements are:

1) encourages the teacher to understand the student's perspective and build meaningful relationships with students

2) is a social process whereby knowledge is socially constructed

3) fosters a deep approach to learning that encourages student independence

4) promotes student activity and engagement with content

5) is contextualised and relevant; teachers have an awareness of student prior learning

6) involves the teacher providing effective and timely feedback to students

The unique conjuncture of student learning research and environmental psychology within this study advanced the six essential elements through the extrapolation of possible teaching and learning behaviours, inferred throughout the effective teaching and learning discourse. These behaviours form the basis of the Effective Teaching and Learning Behavioural Framework (Table 4) that concluded Chapter 3.

Following evaluation of the case studies in this study, the preliminary Effective Teaching and Learning Behavioural Framework (refer Table 4) has been expanded to include a set of spatial consequences. These spatial consequences describe the classroom conditions that are aligned with the Effective Teaching and Learning Behavioural Framework. For example, to support a teacher's endeavour to understand the student's perspective and build meaningful relationships (Essential Element 1) it is proposed that the teacher would need to be able to move around the classroom to access all students (to engage in discussion and observation) and that the teacher should be able to access every student equally and equitably. In order for the teacher to access every student equally and equitably in the classroom, the classroom would need to have enough space for the teacher to easily move around and access every table and chair. In other words there would be a degree of spaciousness in the classroom to enable the teacher to access every student equally and equitably.

As a result of analysing the spatial consequences, six repetitive spatial themes began to emerge. These themes, presented as 'spatial characteristics', are a product of synthesising the spatial consequences to its minimalist condition. The combination of: a) the Essential Elements of Effective Teaching and Learning, b) Effective Teaching and Learning Behaviours, c) Spatial Consequences and d) Spatial Characteristics, form the Effective Teaching and Learning Spatial Framework (Table 27).

Table 27

The Effective Teaching and Learning Spatial Framework

Effective teaching and learning...		Effective Teaching & Learning should make it possible for:
1.	**encourages the teacher to understand the student's perspective and build meaningful relationships with students**	- the teacher to move around the room and access all student equally and equitably
		- the teacher to engage with students individually, in small groups or as a whole cohort
		- the teacher and students to access the same educational technologies (such as digital screens)
2.	**is a social process whereby knowledge is socially constructed**	- students to interact at a 'personal' or 'social' distance as tasks are being established
		- students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance
		- different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.
3.	**fosters a deep approach to learning that encourages student independence**	- students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions
		- students to work at their own pace
		- different students to engage in different activities at the same time
4.	**promotes student activity and engagement with content**	- students to engage with the learning content in a variety of ways that may be individual or group-based
		- students to utilise learning resources including the available technologies
		- students to capture content presented by the teacher and/or the product of interactions with other students.
		-Student groups to equitably access educational technologies
5.	**is contextualised & relevant; teachers have an awareness of student prior learning**	- the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences
		- students to undertake learning activities that are relevant to them and their learning context
		- students access resources relevant to their needs
6.	**involves the teacher providing effective and timely feedback to students**	- the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance
		- the teachers to meet individually and/or privately with students to provide direct feedback
		- student groups to display the product of their interactions and discussions for the teacher and other students to see
		- students to present their work to the teacher and the entire class for feedback

Spatial Consequences to help make effective teaching and learning behaviours possible:	Spatial Characteristics
Space between table settings to move around.	**SPACIOUSNESS**
Space for the teacher to easily move around between table settings. Space for the teacher to access and talk to individual students. Space for the teacher to access and talk to small groups of students. A central location for the teacher to facilitate a discussion with the whole class.	**SPACIOUSNESS**
Wall space for the educational technologies; space to access them.	**ACTIVE SURFACES**
Furniture settings to enable students to work together in small groups, where distances between interactions may commence at 1.2 – 4.0m but progressively become closer.	**GROUP SETTINGS**
Furniture settings to enable students to work together in small groups or pairs in close proximity (i.e. less than 1.2m).	**GROUP SETTINGS**
Mobile furniture settings to enable students to rearrange furniture (if required) so they can work together in large groups, small groups, in pairs or individually, and for this variety of interactions to take place simultaneously.	**MOBILE FURNITURE**
Mobile furniture to reconfigure the classroom, including for example, creating a quiet area for reading and thinking in one area and a collaborative discussion in another area of the room.	**MOBILE FURNITURE**
Furniture settings in which students can undertake focused work, or access resources independently to work at their own pace, including being able to move to a quiet part of the classroom.	**MOBILE FURNITURE** **VARIETY OF FURNITURE**
It is possible to reconfigure the room for different activities and for different activity settings to be available. For example, a writeable surface for brain storming or a group setting with a computer for internet research.	**VARIETY OF FURNITURE**
Furniture settings to enable students to work together individually or in small groups, which may include access to educational technologies and variety of furniture settings. Space between furniture settings to move around.	**GROUP SETTINGS** **VARIETY OF FURNITURE** **SPACIOUSNESS**
Access to walls where writeable surfaces, pinboards and/or digital screens can be located, preferably in close proximity to group settings. (Note, does not preclude glass partitions from being incorporated into classroom design.)	**ACTIVE SURFACES**
The ability to download content to be shared using a variety of educational technologies (on active walls), including student-owned devices.	**EDUCATIONAL TECHNOLOGY**
Multiple sets of technologies: one per group	**EDUCATIONAL TECHNOLOGY**
Versatile technologies to support the teacher spontaneously using alternative internet-based resources or accessing writeable surfaces or conducting a whole of class discussion.	**EDUCATIONAL TECHNOLOGY**
Access to all features of the room, including furniture settings, active walls, active floor and educational technologies. Furniture settings to enable individual or group work.	**ACCESSIBLE TECHNOLOGIES** **GROUP SETTINGS**
Access to walls where writeable surfaces, pinboards and/or digital screens can be located, preferably in close proximity to group settings. Access to internet-based devices, including good quality wi-fi.	**ACTIVE SURFACES** **GROUP SETTINGS** **ACCESSIBLE TECHNOLOGIES**
Visibility of active walls where digital screens, writeable surfaces and/or pinboards are located, enabling the teacher to view progress from a distance.	**ACTIVE SURFACES**
Space for the teacher to access and talk to individuals and small groups of students.	**SPACIOUSNESS**
Wall space for students to write-up ideas and summaries of interactions (digital or writeable surfaces) which can be viewed around the room by the teacher or other students.	**ACTIVE SURFACES** **ACCESSIBLE TECHNOLOGIES**
Presentation screens (central or local to each group); good sightlines bewteen groups.	**ACCESSIBLE TECHNOLOGIES**

9.3.1 Spatial Consequences and Characteristics

A critical finding of this study is the compelling relationship between effective *teaching and learning* (as described in the student learning research literature), effective teaching and learning *behaviour* (as inferred from the environmental psychology literature) and the spatial *consequences* relational to the effective teaching and learning behaviours. The Spatial Consequences, as described in Table 27, have been synthesised into six essential spatial characteristics that are considered critical to the design of NGLEs. They are:

1) spaciousness

2) mobile furniture

3) group settings

4) variety of furniture settings

5) accessible educational technologies (to students)

6) active surfaces

These characteristics do not ignore previously acknowledged indoor environmental qualities (IEQs) that are known to affect the experience of learning, such as natural light, thermal comfort and fresh air (Nair & Fielding, 2005; Tanner & Lackney, 2006). Rather, the six essential spatial characteristics listed are considered complementary to accepted IEQ conditions.

It is the author's contention that NGLEs which exhibit most or all of these characteristics are likely to increase the possibility of effective teaching and learning taking place. These spatial characteristics are deliberately non-prescriptive, to encourage design diversity and teacher flexibility. The remainder of this chapter explores each spatial characteristic in greater detail, to explain the critical relationship between pedagogy and human behaviour as observed in the case study examples. For the purposes of this analysis, the CTLC at the University of Queensland has been divided into small and large classrooms, to distinguish variations in the spatial characteristics of each classroom size.

9.4 EFFECTIVE TEACHING AND LEARNING SPATIAL CHARACTERISTICS

9.4.1 Spaciousness

9.4.1.1 Space Planning Guidelines

Spaciousness should not be misinterpreted in space planning guidelines that often determine the space allocation for university archetypes. For example, the *TEFMA Space Planning Guidelines* benchmark classroom types and sizes across Australian and New Zealand universities (TEFMA, 2009). Facility managers regard space efficiency as a key performance indicator for classrooms, particularly classrooms that demonstrate high utilisation and frequency of use. Targeted space efficiencies result in high-density occupation of space; that is, students located in crowded seating arrangements. As already discussed in this discourse, such settings inhibit movement by teachers and students, relegating students to their seats and the teacher to the front of the room. These settings reinforce teacher-centred teaching and inhibit effective teaching and learning practice—creating environments that represent the antithesis of spaciousness.

Tiered lecture theatres are typically expected to be designed to accommodate one student per 1–1.8 m2, whereas tutorial rooms and flat floor lecture theatres are expected to accommodate one student per 2 m2 (TEFMA, 2009). Definitions for 'new generation learning environments' have not yet been developed in the TEFMA space planning guidelines and therefore no typical area rates have been established. However, as NGLEs become a recognised classroom typology on university campuses, benchmarking will be inevitable. A comparison of space-to-student ratios of the NGLEs in this study revealed a consistent ratio of one student per 3–4 m2 (see Table 29).

Table 28
Area Per Student in Case Study Spaces (Room Area Divided by Capacity)

DILE	CTLC – large	CTLC – small	Learning Lab	PBL studio precinct
3.5m2	3.8m2	3m2	3.25m2	4m2

However, it should not be construed that NGLEs can all be designed to incorporate this basic parameter. The majority of these case studies were constructed within existing infrastructure, meaning that the volume was generally fixed. The capacity of the room was required to be negotiated during design, which in turn determined the space-to-student ratio. For example, in the Learning Lab at the University of Melbourne, a transformed redundant lecture theatre, the learning space designer articulated that capacity of the room was a seriously debated issue during design:

> *"All we needed was for the teaching team who would be using it to confirm what the class size would be. And the sticking point was always that [they] insisted that a class had to be 60 students. It seemed to me from the very beginning that you could not have 60 students working in the way—in small groups. My gut feeling was 40 and I said, 'We're only going to be able to get 40 in this room'. And he said, 'Well, it will only work with 60. We can't go below 60. You need to comply with that sort of number to make the whole thing work as an economic model for chemistry'. But after some time they went away and did whatever they do and subsequently [they] confirmed that they could actually live with 40"* (Learning Environment Designer).

It is difficult to imagine how the Learning Lab would have worked with a capacity of 60 students. While a capacity of 60 students may have been possible, it would have been considerably more crowded, with a space ratio of only 2.1m2 per student, similar to that in a traditional tutorial classroom. The teacher would be less likely to easily move around the room and the range of possible learning activities would have been considerably reduced. The student capacity of a NGLE is therefore one of the most crucial decisions to be made in the design process.

The space-to-student ratios in Table 29 are in some respects misleading in terms of spaciousness. It should not be assumed that the Learning Lab (3.25 m2 per person) is less spacious than the DILE (3.5 m2 per person), or that the EE PBL precinct (4 m2 per person) is more spacious than the CTLC classrooms (3–3.5 m2 per person). In fact, the opposite is true in each example. The space-to-student ratio does not factor in how much furniture is present in the space; an element that affects the degree of movement enabled throughout the space. The Learning Lab has contained the table settings to fixed locations, with deliberate concern for the spaciousness between each setting. The DILE contains a lot of furniture but there is one major area of congestion surrounding the location of the fixed desktop computers. It was not understood during design that students would be collaborating around the computers, although this is what often happens during class. Up to 12 students were observed attempting to share three computers along a 2.4-m length of desk.

Because of the location of other furniture nearby, it was impossible for the teacher to access the majority of students in this area and this is considered a significant flaw of the space.

The PBL precinct and the large CTLC classroom may appear in Table 29 as being similar in their space-to-student ratios; however they are very different environments. Essentially the PBL precinct comprises shared facilities and circulation zones that are included in its ratio of one student every 4 m2. The 'studio' where students spend most of their time studying is only 14 m2 and is shared by up to six students, reducing the space-to-student ratio in the studios to one student per 2.3 m2. This presents a vastly different picture from that of the whole precinct, which technically has one student per 4 m2. The large CTLC classroom on the other hand is a single classroom with a sense of significant spaciousness.

Benchmarking is a useful tool to assist facility managers in planning for new infrastructure. Based on the case studies examined in this study, somewhere between 3 and 4 m2 per person appears to be an appropriate amount of space for a NGLE. However the final ratio will be affected by the efficiency of the building (e.g., the location and frequency of columns), the shape of the room and the former use of the space. Whether a NGLE is being planned for new or existing infrastructure, the capacity of the room is a critical decision to be confirmed early in design. The capacity of the room should reflect the need for spaciousness and the range of anticipated teaching and learning activities, resisting any temptation to fill the room with students and furniture simply because they may technically fit.

9.4.1.2 Freedom to Move

Spaciousness is a three dimensional quality often associated with having ample room to move, although it has greater implications for bestowing a sense of freedom for the occupants of space. While Tuan declares that "a setting is spacious if it allows one to move freely", he also asserts, "spaciousness is closely associated with the sense of being free. Freedom implies space; it means having the power and enough room in which to act" (Tuan, 1977, p. 52).

Space is objective and tangible; it has a volume that is measurable. The elements and number of occupants within a space contribute to its sense of 'spaciousness'. A 60-m2 space with a 3-m-high ceiling and minimal furniture will feel spacious to a single occupant, but the same space with 60 occupants will most likely feel crowded. Depending on the number of occupants, the ceiling height and other elements within the space (e.g., furniture), the point at which the room begins or ceases to feel spacious is subjective and difficult to define.

The sense of spaciousness will be influenced by the distance between people and fixed objects such as furniture. The higher the density of occupants and furniture in a space, the more difficult it is for movement to occur. A room may seem crowded by having a high density of furniture but few occupants, and vice versa. Drawing on Hall's taxonomy of human distance (Hall, 1970), people experience different relationships with other people at different distances. Lawson (2001) points out that people experience multiple human distances in most spaces. This is particularly true of students who commonly relate to each other at 'intimate', 'personal' and 'social distances', while lecturers commonly experience their students at a 'public' distance of over 4 m. Varying floor levels may also increase a sense of spaciousness by enlarging the volume, providing that the quantity of occupants and furniture does not inhibit the sense of spaciousness.

In the context of NGLEs, having ample space to move around is fundamental, not only by enabling the teacher to move easily around the room to engage with students, but by enabling students to move freely around the room, engaging with other students and participating in a variety of learning activities. However, as per Tuan's interpretation, spaciousness in a classroom environment should engender a sense of freedom in students to initiate activities, access resources or engage with others, relevant to their learning objectives. Effective teaching and learning practice would be demonstrated when a teacher provides some structure and guidance but liberates students to take ownership of their learning experience. Students should be empowered to access resources and people beyond the classroom. The teacher should be able to access all students equally, to directly engage with them to better understand their perspective. Spaciousness generates possibilities for students to engage with each other either through planned activity, or through spontaneous, serendipitous opportunity.

At the University of Queensland, the architect described that the spaciousness of the large CTLC was deliberately designed in anticipation of students being able to congregate in the central area for instruction, explaining that:

> *"creating enough space in this area for* [students] *to bring the chairs in to have that as a structural didactic mode. So we did know they had to shift; that's one thing we did understand from the discussions … which is why there's so much space in that central section"* (Architect).

The architect's own observations contrasted with this design intention adding 'most of the students just sort of turn around and crane their necks to sort of work it out' rather than shifting their chairs to the central area. However, T4 at the University of Queensland described the benefit of having all (90) students move their chairs into one part of the room to instigate a more intimate whole-group discussion rather than remaining dispersed throughout the large space.

T4 also described that one of the activities she implemented in the large CTLC classroom was based on role play, utilising the spaciousness of the room to enable multiple groups of students to spread out and undertake the activity without being unduly distracted by others. This was not necessarily anticipated in the design, but became a possible activity because of the spaciousness of the classroom.

While the concept of spaciousness often focuses on the horizontal plane incorporating furniture and floor space, it can also be interpreted vertically in terms of the height of a room. The learning space designer for the Learning Lab at the University of Melbourne described the deliberate use of height between furniture settings:

> *"What I thought we could do with the steps was create a sense of separation, they have different horizontal planes in the room, and they're only a step height ... my presumption all along was that if we could get people to be, in a sense out of kilter spatially, they would be primarily aware of their own group and themselves in that group and have a very secondary awareness of everybody else in the room"* (LED).

Some instances of interaction between students in different zones were observed, but essentially students were focused on tasks in their immediate area. This supports the learning space designer's contention that the use of height to separate zones enables students to maintain concentration without being distracted by student in adjacent settings.

Observations in the Learning Lab and CTLC classrooms revealed how teachers used the open spaces in the rooms to surreptitiously 'scan' and identify students who may require assistance, reducing the need to interrupt or dominate proceedings. This demonstrates effective teaching and learning in the sense that by maintaining a presence in the background, teachers can evaluate student progress from a 'social' or 'public' distance yet be available to assist students when needed.

Spaciousness enables freedom, creativity, spontaneity and serendipity within a learning situation. Students and teachers can move unencumbered around the room to benefit interaction and communication. It enables floor space to be used in creative ways, from students sitting (or lying) on the floor or developing a performance, to spreading material out or facilitating the use of instruments. Spaciousness is a valuable educational commodity that has been identified as a critical spatial feature of NGLEs.

9.4.2 Mobile Furniture

Mobility is the ability for a piece of furniture to be easily moved without undue effort; for example, chairs and tables on castors, or lightweight furniture that can be easily relocated or reconfigured. Historically furniture in most university settings has been either fixed or heavily constructed, to avoid mobility. Typical educational settings have been established to focus on the teacher, inhibiting reconfiguration of furniture that may place greater emphasis on student activity and initiatives. Immobile furniture may not necessarily lead to stagnant minds, but it does signal to students that they are to remain fixed and focused on the teacher, reducing any sense of learning initiative.

Developing student independence, as a recognised objective of effective teaching and learning, is partly orchestrated by empowering students to take ownership of their environment. If a student is compelled to manipulate the physical environment to enable specific learning activities, then that student is demonstrating initiative. Effective teaching would encourage such initiative within the physical limitations of the classroom.

Mobile chairs are a key characteristic of NGLEs. Chairs on castors featured in the CTLC classrooms at the University of Queensland as well as the Learning Lab at the University of Melbourne. Easily movable lightweight chairs were featured in the Deakin University DILE and Victoria University EE PBL studios. Chairs on castors in the CTLC and Learning Lab were, at the time, considered somewhat audacious by the facilities team at the respective universities. However, they enabled students to easily manoeuvre their chairs into close proximity with peers, or to relocate from one setting to another.

In the smaller CTLC classrooms students were observed oscillating between collaborative discussion settings in the centre of the room and computer-based activities around the perimeter of the room, simply by moving their chairs.

The Learning Lab also had chairs on castors, although little mobility was observed, apart from manoeuvring of chairs around the table in relation to the configuration of the ‘butterfly wing’ table top leaves. Even though some academics expressed that they did not encourage student mobility around the room, the LED mentioned that one of the educational intentions of the room was to enable students to move around, exploring each other’s work and progress. He said:

> *“Educationally I felt that if we’re talking about small groups, you don’t just want to pin people into the same group all the time. People might want to be able to move themselves or the teacher might require them to move and another student might require them to move. So trying to enable movement through the room was also a little bit critical ... The room had to bespeak movement. It had to enable people to be able to move through the room”* (LED).

Although the classroom was designed with the intention of enabling mobility among students, it was actually the teachers who inhibited the behaviour, by facilitating activities that took place at each group setting. Mobility could have been encouraged by the teacher, by prompting students to investigate and compare what other student groups were doing.

Power and hardwired data supply to computers and other equipment naturally prevents mobility of some furniture, particularly tables. This is one of the most difficult spatial elements to contend with in the design of NGLEs, as it can become a significant constraint for where and how learning activities are enacted. The Learning Lab tables were symptomatic of this, with two desktop computers located at each table setting. Power and data cables were directed through the floor underneath each table setting, thereby anchoring the table setting to a permanent location. While laptops were considered for the Learning Lab, desktop computers were anticipated to yield greater performance in terms of speed, reliability and internet connectivity. Processes for recharging laptops and utilising wireless networks have considerably improved since the construction of the Learning Lab and would likely be installed in future NGLEs. Although the tables were fixed in position, it was noted by the researcher that this did not appear to diminish the pedagogical adaptability of the space. The possibilities for a plethora of learning activities exist despite the fixed nature of the tables. The mobility of furniture, especially chairs, coupled with spaciousness, enables students to develop initiative by manipulating the physical environment to support the learning activities that are relevant and immediate to their needs.

9.4.3 Group Settings

In order to implement collaborative learning it is essential to provide furniture settings at which students can work together. In the context of a NGLE the size and shape of tables at which students sit together, presents the affordance for conducting collaborative learning. Throughout the case study examples in this study, there have been several different examples of group settings, some more successful than others.

In the DILE at Deakin University, the Boardroom Table setting (refer figures 23, 24 & 25) was observed being effectively used for a whole of class discussion. Figures 24 & 25 demonstrate how small groups could effectively interact across the corner or across both sides of the table. However, figure 25 indicates the difficulty in collaborating when students are situated in a line along one edge of the table. This scenario was observed in Observation 3 (Chapter 5) where a group of four students were lined up in a row, despite the opportunity to relocate to the corner where they would have all been in closer proximity to each other. It was not clear why they did not move, indicating a lack of awareness that their interaction would potentially have been easier across the corner.

The CTLC large and small classrooms at the University of Queensland presented group settings very differently. The small classrooms incorporated large and small 'kidney-shaped' tables. Both sized tables were on castors, enabling easy mobility. The small tables were well suited for three or four students to sit around. The larger tables were suited for groups of six or seven. The difficulty with the large tables was the distance between participants across the table. The widest dimensions of the table were 1.2 metres across and 1.5 metres in length, meaning there was considerable distance between participants, potentially impacting on the ability for students to hear each other speak. The large classrooms incorporated a completely different set of collaborative settings, intended for groups of up to eighteen people. As was discussed in Chapter 6, eighteen students was considered too large to operate effectively as a single group. However, the convex portions of the fixed curvilinear desks appeared to enable small group interactions, refer figures 49 and 50. Throughout the large classrooms there were areas of concave-shaped desks, as shown in figures 49 and 50. The inward curve is considered a sociofugal setting, making it difficult for groups to effectively interact. This was observed in Observation 4 (refer figure 81) where a group of six students were attempting to collaborate around a single computer.

The Learning Lab at the University of Melbourne comprised a series of bespoke ‘butterfly’ shaped tables to suit groups of four or eight students. As was discussed in Chapter 7, teachers did not initiate group work for explicit numbers of students, but rather allowed collaboration to occur synergistically. There were not any observed instances where eight students collaborated across the butterfly table. Although the two computer screens on each table setting were fixed to moveable brackets and could be manoeuvred out of the way, some teachers expressed that the computers were an obstruction to some forms of collaboration.

The EE PBL studios at Victoria University comprised a meeting table at which groups of up to six students could work together. The table was approximately 1.2 x 1.2 metres, providing a compact environment where all students were located in close proximity, or at an intimate to personal distance as described by Edward T. Hall (1970). The desktop computer was located at the end of the table against a wall, thereby not creating an encumbrance in the work zone. Of all the group settings in the case study examples, the simple compact rectilinear tables within the EE PBL studios appear to have been the most effective for enabling collaboration.

The shape and size of a classroom table, as well as the location of equipment such as desktop computers, collectively has an impact on the effectiveness of the furniture setting for enabling collaborative learning. Careful planning is required to firstly understand how many students will be working together, followed by exploring table shapes and sizes to test proximity of students to each other. Tables that are too large or the wrong shape can dramatically dimish the opportunity for collaborative learning to effectively take place.

9.4.4 Variety of Furniture Settings

A variety of furniture settings in the classroom enables different activities to simultaneously take place. In the context of effective teaching and learning this establishes choices for students, further developing their learning initiative. Teachers may assign learning objectives and guidelines but enable students, through consultation, to plan and implement activities to achieve those objectives, as was the case for third year students in the DILE classroom at Deakin. Regardless of whether students are working collaboratively or individually, a multiplicity of activities may occur concurrently during any learning episode. Enabling a variety of activities presupposes that students can work at their own pace, influenced by their prior learning experience and perspective on their learning situation. Therefore, providing a variety of furniture settings that enables a multiplicity of concurrent learning activities would support many of the characteristics of effective teaching and learning.

This is in distinct contrast to furniture settings within traditional classrooms such as lecture theatres and tutorial rooms. Lecture theatres typically contain one type of fixed seat facing the teacher, with a tablet for writing on. Tutorial rooms typically have modular furniture, which although potentially mobile, is conventionally set out in rows facing the teacher. Even when student activities are implemented, the experience would generally involve all students undertaking the same activity.

The EE PBL precinct at Victoria University provides a variety of settings in different spaces that have each been designed for different purposes and activities. Students undertake most of their work in the studio, moving to the laboratory for technical activities or to the common room to take a break. The precinct caters to the specific needs of different types of activities. Laboratory-based activities utilise specialist equipment that is shared by the entire cohort of students and must be located in a space that can be supervised by the laboratory technician. The common room features a sink, refrigerator and microwave that are also shared by the entire cohort of students, as well as providing cafe-style seating where students can relax while taking a break from study. As a precinct it is crucial to have this variety of spaces.

In the DILE at Deakin University a variety of furniture settings was established to emulate aspects of a commercial work environment. The boardroom table setting was for large group discussion or focused small group discussion. The computer bench was for computer-based activities. The standing-height tables were for quick meetings around laptops and the lounge was for creative thinking and brainstorming. However, T1, the primary academic stakeholder, reflected in hindsight that designing different settings for different activities reduced the ‘seamless integration of everything’, stating:

> *“it’s really important that students don’t have to make those decisions, that they don’t have to say, ‘we’re talking now, we’ve got to move over here’. That’s a complete anathema to what it should be like”* (T1).

This reflective reservation is primarily centred on the collocation of computers, which requires students to consciously move when they need to undertake computer-based activities. The variety of furniture settings is not necessarily the problem, but rather the specific need to relocate to access computers. If the DILE were to be designed again, the primary academic stakeholder described that she would have computers distributed around the room to support students regardless of their location or activity.

While the Learning Lab at the University of Melbourne does not appear to have a variety of furniture settings, it cleverly integrates a wide range of possibilities within each group setting, providing pedagogical flexibility beyond the possibilities of any other single space evaluated in this study. Each of the five identical furniture settings in the Learning Lab enables activities, such as computer-based tasks, utilising the document camera, brainstorming on the whiteboard, sharing content via the LCD screen or simply having a small group discussion. In many ways the Learning Lab at the University of Melbourne responds to the dilemma expressed by the primary academic stakeholder for the DILE, providing a setting where activities can be seamlessly integrated without significant conscious effort.

Enabling a variety of activities is a critical characteristic of NGLEs to support effective teaching and learning and can be achieved through the provision of a variety of furniture settings, or settings that are purposefully designed for a variety of activities.

9.4.5 Accessible Educational Technologies (to Students)

The NGLEs evaluated in this study all provide internet access to students with computers at a ratio of one computer per three students, or lower. This negates the computer laboratory effect of one person per computer, which may tempt students to be distracted by personal interests. The lower ratio of computers promotes collegiality and cooperation among students, increasing the likelihood that computers in the classroom will be utilised in a manner that is relevant and symptomatic of effective teaching and learning.

In contrast to standard classrooms on campus, where educational technologies are the domain of the teacher, the NGLEs examined in this study are distinguished by an emphasis on enabling shared student access to the educational technologies within the classroom. Further, students increasingly carry internet-enabled devices to class such as laptops, smartphones and tablets, increasing the necessity for students to access reliable and fast Wi-Fi systems. Students can use their devices to enhance the learning experience and promote collaboration by capturing content, accessing web-based resources or sharing material with peers.

The university's investment in sophisticated intranet services has created a hybrid learning environment where students can access unimaginable quantities of information wherever they have access to the internet. As internet-enabled computer resources are a key characteristic of NGLEs, students can access a world of knowledge relevant to the context of their learning encounter.

Critically, the computers in each of the NGLE case studies are located as shared resources with a ratio of one computer to every 3–5 students. This establishes the presumption that students will engage in learning activities both with and without computers, and encourages their cooperative and interactive use. Access to computers presents possibilities for teachers and students to implement a variety of learning activities in a variety of contexts; for example, establishing tasks that will require internet access, enabling students to conduct research, or simply to seek information to contribute to discussion and assignments.

The presence of computers in NGLEs begins to normalise the experience of accessing internet resources at any time. In this sense, effective teaching and learning is enhanced through the choices and possibilities presented to teachers and students by accessing internet-based resources in real time, reacting to spontaneous demand in relation to relevant learning activities.

The sophistication of technologies in the large CTLC classrooms at the University of Queensland was a unique feature. It was unusual in the sense that educational technology of that experiential quality and type had rarely been installed in classrooms before that time, and unique in the sense that the room was specifically designed to enable student groups to access a range of sophisticated resources. In a deliberate attempt to encourage collaboration and interaction through the use of computers, and to ensure that the classrooms were not perceived as computer laboratories, computers were installed at a ratio of one computer per three students. The large classrooms also feature a unique characteristic that enables the room to be subdivided into five zones, each with its own data projector and control function, referred to by the university as 'pod mode'. Electronically operated drop-down screens not only subdivide the space, but also combine the dual function of a projection surface.

Each zone can operate independently to facilitate focused group work, reducing distractions from adjacent groups, yet can transform back to a whole-group setting within seconds. The teacher can also share the work of a group of students with one or all of the other zones, instigating discussion or demonstrating excellent work by others. While this is clearly a state-of-the-art technology, there was a sense that this capability was underutilised. One teacher interviewed confirmed she used the zoning feature for one of her classes, but more so to create a sense of privacy for sensitive discussions between small groups of students rather than to utilise the technology. The underlying sense was that teachers did not know how to use the zoned settings pedagogically, even when they were capable of operating the technology. It appeared that academics had not risen to the challenge of devising relevant and meaningful ways of utilising multiple zones for large cohorts of students. The zoned setting, or pod mode, appeared to present a challenge to teachers in planning activities that were relevant to their learning objectives and engaging for large groups of students.

Although a professional development program was established at the University of Queensland to demonstrate ways of utilising the CTLC zones and technology for teaching and learning, it was equally important that the technology did not become the primary focus of teaching and learning activities, but rather was viewed as a supporting resource. In this sense the technological capabilities of the large CTLC classrooms may have exceeded requirements. Since the completion of the original CTLC the University of Queensland has completed second and third generation versions of the CTLC. In each case they moved away from physically zoning spaces and adopted screen-based rather than projection-based technologies. For example, the second generation CTLC at the University of Queensland Gatton campus features meeting tables for up to nine students, each with a retractable LCD screen at one end and with a number of laptop docking stations. When the teacher addresses the whole class the LCD screens retract to maintain student focus. When students are working collaboratively, students at each table can view resources on the LCD screen and undertake activities on the laptops docked at each table.

The learning space designer for the CTLC also designed the Learning Lab at the University of Melbourne, applying considerable design intelligence and drawing upon the strengths and weaknesses of the CTLC. Students have access to internet-enabled desktop computers at a ratio of one computer per four students. Each group setting has access to an LCD screen that can be controlled by either the teacher or the students. Teachers can demonstrate and present to individual LCD screens or to all of them; students can develop group work on their local LCD screen and then share it with the whole group across all LCD screens. The technology was devised to support and enhance effective teaching and learning, presenting possibilities limited only by one's imagination.

9.4.6 Active Surfaces

NGLEs are about promoting effective teaching and learning, whereby "what the student does is actually more important in determining what is learned than what the teacher does" (Shuell, 1986, p. 429). A key aspect of this is being able to express oneself and to share and communicate cognitive activity with others in the room.

Students build confidence in their learning process when they can see or hear what other students are doing. Whether a student is working individually or in a small group, it is reassuring for them to know they are on the right track. Inspiration and motivation can occur when students see other students productively engaging and, crucially, view the product of that engagement. A classroom environment can facilitate this with 'active surfaces'; that is, walls and floors that can be used for different learning activities. Examples of active walls include whiteboards, pin-boards, blank walls for projection and wall-mounted LCD or plasma screens. An active floor may consist of unoccupied floor space—either permanently vacant or created by moving furniture out of the way—where an array of alternative activities may take place. For example, another NGLE, not part of this study, deliberately incorporated vacant floor space into the classroom, which became the destination for robot racing among engineering students. This activity was not necessarily anticipated during design, but became possible because of the active floor space within the room.

The Learning Lab at the University of Melbourne incorporates active walls via the location of LCD screens and whiteboards in each of the five group zones. Importantly, these 'tools' are not only visible to students in the immediate proximity, but to teachers and students around the room. Making effective use of active walls, however, requires the teacher to enable activities that encourage students to use that feature. The learning episodes observed in the Learning Lab did not provide students with this opportunity. The whiteboard was observed being used by the teachers, but not the students. The fact that the walls were not observed being used by students does not mean this did not occur at other times. Teachers interviewed for this study described a range of activities implemented in the Learning Lab across a semester, only some of which were directly observed by the researcher. The active walls in the Learning Lab remain nonetheless, a vital feature of the space.

The EE PBL studios at Victoria University have active walls, with pin-boards and whiteboards making up the internal surface of the studio partitions. The whiteboards appeared to be used by students for testing and developing theoretical ideas, as the remnants of those activities were extensively visible on whiteboards throughout the PBL precinct. However the constraints of the demountable partitioning system dictated a modular size and location of the whiteboard that may not have been as effective compared with a plasterboard wall where a larger whiteboard may have been more appropriate.

In contrast, the Deakin University DILE and the University of Queensland CTLC classrooms featured walls that were noticeably underutilised. The DILE featured a fixed whiteboard that was concealed when the projection screen was activated. A mobile whiteboard appeared to be used extensively by students, although the facility manager expressed that the framing system and castors at the floor of the mobile whiteboard unit were generating concern that it may be a trip hazard, resulting in its likely removal from the room.

The large and small classrooms in the CTLC feature projection surfaces and some whiteboards. The curvilinear walls and materiality of the small classrooms prevent the walls from being activated to any degree, although the location of the computer screens around the perimeter does provide the potential for students to monitor what other students are doing. The large classrooms have drop-down projection screens for student groups to utilise in 'pod mode' but because of the deliberate segregation of specific zones, students are unable to monitor other students without explicitly moving outside of their own pod.

The ability for students to monitor other students in the room, and for the teacher to easily monitor what students are doing, is an underestimated benefit of learning in the classroom. Monitoring is enabled through 'active wall' features where students can develop ideas, plan assignment tasks and demonstrate understanding that is displayed for the teacher and other students to see. While the NGLEs in this study demonstrated active surfaces with varying degrees of effectiveness, this is a spatial feature that should be considered in future examples, to facilitate experiential learning, knowledge sharing and monitoring among students and teachers.

9.5 SUMMARY

The summary in Table 29 outlines the spatial characteristics identified in each of the NGLEs evaluated in this study, adopting a simple tick/cross to confirm if the spatial characteristic is present. Only the small CTLC at the University of Queensland incorporated all six effective teaching and learning spatial characteristics. When compared to traditional classrooms, specifically, a typical lecture theatre, tutorial room and a computer laboratory, only the tutorial room incorporated some of the effective teaching and learning spatial characteristics. This supports the contention that the six effective teaching and learning spatial characteristics are important features of NGLEs, even though not all characteristics were present in each case study. This data also suggests that traditional classrooms such as lecture theatres, tutorial rooms and computer laboratories typically lack the spatial characteristics that enable effective teaching and learning.

Although these findings point to the value of designing NGLEs with the six effective teaching and learning spatial characteristics, we know from the case study observations that alignment of the spatial characteristics does not guarantee that effective teaching and learning will be implemented. The six spatial characteristics make the practice of effective teaching and learning possible, but the degree to which this occurs is reliant upon the teacher intentionally planning to adopt an effective teaching and learning approach. This points to the importance of triangulating the teaching and learning possibilities inherent in the NGLEs with good communication of the NGLEs, teacher development programs and evaluation.

Table 29

Effective Teaching and Learning Spatial Qualities Present in the Case Studies

	Effective Teaching and Learning Spatial Characteristics					
New Generation Learning Environments and Interactive Lecture Theatres	**Spaciousness**	**Mobile furniture**	**Group furniture settings**	**Variety of furniture settings**	**Accessible educational technologies**	**Active Surfaces**
Deakin Immersive Learning Environment (DILE)	✓	✓	✓	✓	✓	✗
University of Melbourne Learning Lab	✓	✗	✓	✓	✓	✓
University of Queensland CTLC Large	✓	✗	✓	✓	✓	✗
University of Queensland CTLC Small	✓	✓	✓	✓	✓	✓
Victoria University PBL Studios	✗	✗	✓	✓	✓	✓
Typical Lecture Theatre (Refer Figure 145)	✗	✗	✗	✗	✗	✗
Typical Tutorial Room (Refer Figure 146)	✗	✓	✓	✗	✗	✓
Computer Laboratory (Refer Figure 147)	✗	✗	✗	✗	✓	✗

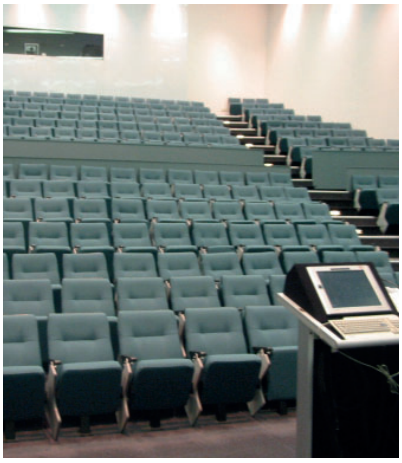

Figure 145: Typical Lecture Theatre

Figure 146: Typical Tutorial Room

Figure 147: Typical Computer Laboratory

9.6 CONCLUSION

This chapter has presented the Effective Teaching and Learning Spatial Framework, a combination of six essential elements of effective teaching and learning, the relational effective teaching and learning behaviours, the spatial consequences required to make effective teaching and learning possible and the six spatial characteristics that form the design basis for NGLEs.

The four NGLEs that form the case studies for this study were analysed in the context of these six essential spatial characteristics, highlighting the fundamental relationship that occurs between educational intention, spatial characteristics and possible teaching and learning behaviours.

Upon further scrutiny of the Framework it became evident that the effective teaching and learning behaviours could manifest as an evaluation device. Through identification of effective teaching and learning behaviours, and situated within spatial characteristics that support an effective teaching and learning process, it became possible to amend the language within the framework to evaluate whether or not the effective behaviours were being enacted. The next chapter details how the Effective Teaching and Learning Spatial Framework has been transformed into the second unique product of this exegesis, the Effective Teaching and Learning Evaluation Tool.

Chapter 10: The Effective Teaching and Learning Evaluation Tool

10.0 INTRODUCTION

Chapter 9 demonstrated how analysis of the four new generation learning environment (NGLE) case studies evaluated in this research culminated in six essential spatial characteristics common to NGLEs. This analysis led to the establishment of the Effective Teaching and Learning Spatial Framework (Table 27), one of the unique by-products of this exegesis. The Effective Teaching and Learning Spatial Framework is underpinned by the theoretical tract of 'effective teaching and learning' and extrapolated to identify reciprocal effective teaching and learning behaviours, as detailed in Chapter 3. This chapter builds upon the Effective Teaching and Learning Spatial Framework, exploring its viability as an evaluation tool and responding to the previously identified difficulties in developing practical evaluation methodologies.

The learning space discourse over the last twenty years has been vexed by the question: do students actually learn better in NGLEs compared with traditional classrooms? With considerable expenditure associated with the design, construction, training, maintenance and upgrade of technologies within NGLEs, universities need to know if the investment is worth it. As presented in Chapter 2, a number of funded research projects have examined methods of evaluating NGLEs, however these projects have raised further questions as to what and how can effectively be measured (Lee & Tan, 2011; Pearshouse et al., 2009; Radcliffe et al. 2009). Universities have placed too much emphasis on attempts to evaluate NGLEs as the cause of improved student learning outcomes. However, the inseparable issue is that NGLEs have become the enabling environment for teachers to practice a more student-centred approach to teaching, which in turn encourages students to adopt a deep approach to learning.

While this study has discovered that NGLEs do not guarantee that teachers will apply a student-centred approach, NGLEs do present an environment in which it becomes possible. Therefore, a more cogent question for universities to ask would be: are new generation learning environments enabling effective teaching and learning practices? This chapter details how the Effective Teaching and Learning Spatial Framework has been adapted to form the second key output of this study, the Effective Teaching and Learning Evaluation Tool.

10.1 THE EFFECTIVE TEACHING AND LEARNING EVALUATION TOOL

The Effective Teaching and Learning Spatial Framework sets out a range of anticipated teaching and learning behaviours that would be possible within a NGLE when an effective teaching and learning approach is adopted, refer Table 27. The spatial characteristics as detailed in Chapter 9, for example, spaciousness, active surfaces and mobile furniture, enable these behaviours to be enacted. In other words, through the intentions of the teacher to practice effective teaching and learning and an appropriate environment to enable the reciprocal teaching and learning behaviours, the implementation of effective teaching and learning is made possible .

In the context of teaching and learning within NGLEs we have already acknowledged that teachers may still practice in a teacher-centred manner, despite the intentions of the NGLE to enable student-centred practices. Therefore, we cannot always rely on observations of teachers with a teacher-centred mindset as a reliable means of evaluating NGLEs. The premise of NGLEs is that effective teaching and learning "can be done"[1] , or "may happen"[2] as a consequence of the design of the environment: effective teaching and learning is possible.

For example, let us view the first behaviour listed within the Effective Teaching and Learning Spatial Framework: the teacher moves around the room to access all students equally and equitably. As described in Chapter 3, "effective teaching and learning requires the teacher to practise a degree of agility in the classroom, to enable change or adapt the learning encounter in response to the perceived perspectiveof the student and the student's awareness of their learning situation" (p.74). The spatial characteristic of 'spaciousness' contributes to making it possible for the teacher to move around and interact with students, to develop meaningful relationships with students.

1 Oxford University Press, 2000
2 Oxford University Press, 2000

The notion of evaluation seeks to establish whether or not the nominated teaching and learning behaviour is possible as a result of the design of the room. We could pose the question: is the room spacious? However, this would yield subjective responses that are difficult to measure. We could pose the question: is the furniture mobile? This would yield a 'yes' or 'no' response but does not offer any real insight as to the broader behaviours to be enabled by the mobile furniture. We could focus on the behaviour by posing the question: can the teacher move around the room to access all students equally and equitably? While this question alludes to the possibility of the teacher being able to move around the room to access all student equally and equitably, it also yields a simplistic 'yes' or 'no' response. Evaluation is more meaningful if respondents are offered greater choice to express their opinion, such as that presented in a Likert Scale. Tullis & Albert (2013) define a Likert Scale as a "statement to which respondents rate their level of agreement" (p123), commonly using a five point scale of agreement.

Therefore, in order to adapt each of the identified effective teaching and learning behaviours into a measurable format, the phrasing needs to be converted to a 'possibility statement' to which respondents can rate their level of agreement. For example, the behaviour: <u>the teacher moves around the room to access all students equally and equitably</u> is converted to a possibility statement: <u>it is possible for the teacher to move around the room to access all students equally and equitably.</u>

This means that the possibility statements can be responded to without the need for each anticipated teaching and learning behaviour to be observed. The benefit of adopting this approach to the possibility statements is that the respondent does not need to be in an actual teaching and learning encounter. Furthermore, the respondent does not actually need to be in the room to participate in the evaluation. The evaluation can occur through a series of images that convey the spatial characteristics and therefore, the possibilities of effective teaching and learning behaviours taking place.

Returning to the previously highlighted possibility statement: it is possible for the teacher to move around the room to access all students equally and equitably. A NGLE that has a 'spacious' characteristic would mean the teacher is able to easily walk around the room including between student groups and able to access each student equally and equitably. There would be no circulation encumbrances and students would not be located in difficult to reach corners of the room. Where 'spaciousness' is demonstrated it is likely a respondent would 'agree' or 'strongly agree' with this statement. In comparison to the context of a traditional lecture theatre, where students are in fixed seats and it is very difficult to reach students sitting in the middle of rows, a respondent would likely 'disagree' or 'strongly disagree' with this statement.

Another example behaviour from the Effective Teaching and Learning Spatial Framework states: the teacher is able to engage with students individually, in small groups or as a whole cohort. This behaviour addresses three separate scenarios and requires separation in order to evaluate each scenario. Therefore, the identified behaviour would be adapted to three separate possibility statements for evaluation as follows:

It is possible for the teacher to engage with students individually.

It is possible for the teacher to engage with small groups of students.

It is possible for the teacher to engage with the whole cohort.

The spatial characteristics of a NGLE would likely yield 'agree' or 'strongly agree' responses to each of the above statements. However, if a lecture theatre was being evaluated through the same lens, it would likely only yield 'agree' or 'strongly agree' as a response to the possibility of the teacher engaging with the whole cohort.

Table 30 demonstrates how the behaviours within the Effective Teaching and Learning Spatial Framework (Table 27, p.269) have been adapted to statements that express the possibilities of these behaviours being enacted.

Table 30.

Effective teaching and learning behaviours converted to possibility statements

Element	Effective Teaching & Learning Behaviours	Possibility Statements
1	- the teacher moves around the room to access all students equally and equitably;	It is possible for the teacher to move around the room easily and access all students equally and equitably.
	- the teacher is able to engage with students individually, in small groups or as a whole cohort	It is possible for the teacher to engage with students individually.
		It is possible for the teacher to engage with small groups of students.
		It is possible for the teacher to engage with the whole cohort.
	- the teacher and students to access the same educational technologies	It is possible for the teacher and students to access the same educational technologies (such as digital screens)
2	- students to interact at a ‘personal’ or ‘social’ distance as tasks are being established	It is possible for students to interact at a ‘personal’ or ‘social’ distance as tasks are being established.
	- students to move around to initiate full engagement of tasks at a ‘personal’ or ‘intimate’ distance	It is possible for students to move around to initiate full engagement of tasks at a ‘personal’ or ‘intimate’ distance.
	- different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.
3	- students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.
	- students to work at their own pace	It is possible for students to work at their own pace during class.
		It is possible for students to undertake focused tasks during class.
	- different students to engage in different activities at the same time	It is possible for students to engage in different activities at the same time.
4	- students to engage with the learning content in a variety of ways that may be individual or group-based	It is possible for students to conduct collaborative activities.
		It is possible to easily move the tables and chairs around
		It is possible for students to utilise vacant floor space for learning activities (active floor).
	- students to utilise learning resources including the available technologies	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc
	- students to capture content presented by the teacher and/or the product of interactions with other students.	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.
	-Student groups to equitably access educational technologies	It is possible for student groups to equitably access educational technologies
5	- the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.
	- students to undertake learning activities that are relevant to them and their learning context	It is possible for students to undertake learning activities that are relevant to them and their learning context.
	- students access resources relevant to their needs	It is possible for students to access resources relevant to their needs.
6	- the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.
	- the teachers to meet individually and/or privately with students to provide direct feedback	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.
	- student groups to display the product of their interactions and discussions for the teacher and other students to see	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.
	- students to present their work to the teacher and the entire class for feedback	It is possible for students to present their work to the teacher and the entire class for feedback.

Table 31.

Effective teaching and learning behaviours converted to possibility statements

Element	Possibility Statements	Category
1.	It is possible for the teacher to move around the room easily and access all students equally and equitably.	FURNITURE
	It is possible for the teacher to engage with students individually.	ENGAGEMENT
	It is possible for the teacher to engage with small groups of students.	ENGAGEMENT
	It is possible for the teacher to engage with the whole cohort.	ENGAGEMENT
	It is possible for the teacher and students to access the same educational technologies (such as digital screens)	TECHNOLOGY
2.	It is possible for students to interact at a 'personal' or 'social' distance as tasks are being established.	ENGAGEMENT
	It is possible for students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance.	ENGAGEMENT
	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.	ENGAGEMENT
3.	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.	FURNITURE
	It is possible for students to work at their own pace during class.	PEDAGOGY
	It is possible for students to undertake focused tasks during class.	PEDAGOGY
	It is possible for students to engage in different activities at the same time.	PEDAGOGY
4.	It is possible for students to conduct collaborative activities.	FURNITURE
	It is possible to easily move the tables and chairs around	FURNITURE
	It is possible for students to utilise vacant floor space for learning activities (active floor).	PEDAGOGY
	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc	TECHNOLOGY
	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.	TECHNOLOGY
	It is possible for student groups to equitably access educational technologies	TECHNOLOGY
5.	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.	PEDAGOGY
	It is possible for students to undertake learning activities that are relevant to them and their learning context.	PEDAGOGY
	It is possible for students to access resources relevant to their needs.	TECHNOLOGY
6.	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.	PEDAGOGY
	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.	FURNITURE
	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.	ENGAGEMENT
	It is possible for students to present their work to the teacher and the entire class for feedback.	PEDAGOGY

10.2 THE EFFICACY RATING

The process of converting ‘effective teaching and learning behaviours’ to ‘possibility statements’, that can in turn be used by respondents to measure NGLEs using a five point Likert Scale, has resulted in 25 possibility statements, refer Table 31. To enhance readability of the possibility statements they have been arranged into four categories: 1) Furniture; 2) Engagement; 3) Technology; and 4) Pedagogy, refer Table 31 and Table 32.

As stated previously a five-point Likert Scale has been adopted, which translates qualitative responses, for example, ‘agree’ or ‘disagree’ into quantitative responses as follows:

1 = strongly disagree

2 = disagree

3 = neither agree or disagree

4 = agree

5 = strongly agree

When applied to the 25 possibility statements there is a maximum total of 125 points, aggregated to a percentage value to achieve an ‘efficacy rating’. For example, a total response of 100 points represents an 80% efficacy rating. This means that the learning environment being evaluated has achieved 80% of the available criteria. What is an appropriate efficacy rating for a new generation learning environment? The next section will demonstrate how the evaluation tool has been applied to the NGLEs detailed in the case studies in this research, with the aim of answering this question.

Table 32.

Possibility Statements for the Effective Teachng and Learning Evaluation Tool

No.	Possibility Statements by Category
	Furniture
1.	It is possible for the teacher to move around the room easily and access all students equally and equitably.
2.	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.
3.	It is possible for students to conduct collaborative activities.
4.	It is possible to easily move the tables and chairs around
5.	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.
	Engagement
6.	It is possible for the teacher to engage with students individually.
7.	It is possible for the teacher to engage with small groups of students.
8.	It is possible for the teacher to engage with the whole cohort.
9.	It is possible for students to interact at a 'personal' or 'social' distance as tasks are being established.
10	It is possible for students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance.
11.	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.
12.	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.
	Technology
13.	It is possible for the teacher and students to access the same educational technologies (such as digital screens)
14.	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc
15.	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.
16.	It is possible for student groups to equitably access educational technologies
17.	It is possible for students to access resources relevant to their needs.
	Pedagogy
18.	It is possible for students to work at their own pace during class.
19.	It is possible for students to undertake focused tasks during class.
20.	It is possible for students to engage in different activities at the same time.
21.	It is possible for students to utilise vacant floor space for learning activities (active floor).
22.	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.
23.	It is possible for students to undertake learning activities that are relevant to them and their learning context.
24.	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.
25.	It is possible for students to present their work to the teacher and the entire class for feedback.

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10.3 TESTING THE EFFECTIVE TEACHING AND LEARNING EVALUATION TOOL ON THE CASE STUDY NGLES

Each case study NGLE has been applied to the Effective Teaching and Learning Evaluation Tool by responding to each of the possibility statements, with the numerical ratings shown in Table 33 . With the exception of the VU PBL Engineering Studios, all other NGLEs achieved an efficacy rating above 80%. The Learning Lab and small CTLC classrooms achieved 90% and above. The traffic light graphics of each criteria clearly demonstrate the strengths and weaknesses of each NGLE.

The DILE rated well against most criteria, although rated lower against some of the technology criteria and potential use of floor space. Overall the DILE scored an efficacy rating of 86%. The Learning Lab rated well against all criteria, except furniture, due to the tables being fixed and the inability to reconfigure the room. Overall the Learning Lab scored an efficacy rating of 93%. The large CTLC rated lower than the small CTLC, primarily due to the fixed tables. Both spaces were limited in their provision of writeable surfaces for students to access, hence both spaces scored 3 against questions 18 and 19. Overall the large CTLC achieved an efficacy rating of 85% and the small CTLCs achieved 92%. The Engineering PBL studios at Victoria University were the most difficult to evaluate using this tool, due to the suite of spaces that make up the PBL environment and the fact that there was not one singular 'classroom' in which students carried out their learning activities. The PBL studios scored low against criteria such as mobility of furniture and the possibility of the teacher engaging with the entire cohort. The structure of the PBL program meant that teachers rarely engaged with the entire cohort. The studios also rated poorly against the ability of the teacher to monitor students from a distance to evaluate their progress. Strictly speaking this may be the case, however, teachers maintained contact with students each week through scheduled team meetings. Overall the PBL studios achieved an efficacy rating of 78%.

These findings strongly indicate that when NGLEs have been designed with spatial characteristics to align with effective teaching and learning behaviours, they achieve an efficacy rating in excess of 80%. Although the PBL Engineering studios rated below 80%, it is recognised that this case study is potentially compromised by the multiplicity of spaces that make up the NGLE. Therefore, it is proposed that an efficacy rating of 80% is the minimum benchmark for new generation learning environments.

Table 33.

Effective Teaching and Learning Evaluation Tool applied to the case study NGLEs

		DILE	Learning Lab	CTLC Large	CTLC Small	VU PBL
	Furniture					
1.	It is possible for the teacher to move around the room easily and access all students equally and equitably.	3	5	5	5	3
2.	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.	3	3	3	4	2
3.	It is possible for students to conduct collaborative activities.	5	5	4	5	5
4.	It is possible to easily move the tables and chairs around	4	3	2	5	3
5.	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.	5	5	4	4	4
	Engagement					
6.	It is possible for the teacher to engage with students individually.	5	5	5	5	3
7.	It is possible for the teacher to engage with small groups of students.	5	5	5	5	5
8.	It is possible for the teacher to engage with the whole cohort.	5	5	5	5	3
9.	It is possible for students to interact at a 'personal' or 'social' distance as tasks are being established.	5	5	5	5	5
10	It is possible for students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance.	5	5	5	5	5
11.	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.	5	5	5	5	5
12.	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.	4	5	3	4	3
	Technology					
13.	It is possible for the teacher and students to access the same educational technologies (such as digital screens)	4	5	3	4	3
14.	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc	5	5	4	4	5
15.	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.	3	3	3	3	3
16.	It is possible for student groups to equitably access educational technologies	2	5	3	4	5
17.	It is possible for students to access resources relevant to their needs.	5	5	5	5	5
	Pedagogy					
18.	It is possible for students to work at their own pace during class.	5	5	5	5	5
19.	It is possible for students to undertake focused tasks during class.	4	4	4	4	5
20.	It is possible for students to engage in different activities at the same time.	5	5	5	5	5
21.	It is possible for students to utilise vacant floor space for learning activities (active floor).	2	3	5	4	2
22.	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.	5	5	5	5	4
23.	It is possible for students to undertake learning activities that are relevant to them and their learning context.	5	5	5	5	5
24.	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.	4	5	4	5	1
25.	It is possible for students to present their work to the teacher and the entire class for feedback.	5	5	4	5	3
	Total points out of 125	**108**	**116**	**106**	**115**	**97**
	Efficacy Rating	**86%**	**93%**	**85%**	**92%**	**78%**

10.4 TESTING THE EFFECTIVE TEACHING AND LEARNING EVALUATION TOOL ON OTHER SPACES

As has already been referred to in Section 10.2, by adopting possibility statements to create the evaluation framework, it is feasible to evaluate any classroom environment to measure the degree of alignment between effective teaching and learning behaviours and the possibility of these behaviours being enacted. While this study is focused on demonstrating the pedagogical value of NGLEs, the evaluation framework can also be used to measure the pedagogical value of any formal learning environment. By applying the same lens to traditional classroom spaces such as lecture theatres, tutorial rooms and computer labs, it is possible to evaluate their alignment with effective teaching and learning. Table 34 demonstrates the efficacy rating of traditional classroom spaces. The traffic light graphic also highlights the strengths and weaknesses of each typology.

Table 34 clearly establishes that traditional classrooms such as lecture theatres, tutorial rooms and computer labs are not well aligned with effective teaching and learning behaviours. The lecture theatre scored an efficacy rating of 42% while the tutorial room and computer lab scored 62% and 60% respectively. The lecture theatre rated particularly low against furniture, technology and pedagogy, whereby furniture is fixed, technology is controlled by the teacher and pedagogy is likely to be inherently teacher-centred. The tutorial room rated poorly against the technology criteria, as very little technology or resources have traditionally been accessed by students in this typology. Computer labs have technology, that is desktop computers, for students to use but rated poorly against the possibility of working in groups and reconfiguring the room.

Therefore, by adopting the Effective Teaching and Learning Evaluation Tool it is possible to conclude that lecture theatres, tutorial rooms and computer laboratories – the traditional classroom typologies that have dominated the student higher education experience in the past – are not as appropriate for implementing effective teaching and learning practices compared to NGLEs.

Table 34.

Effective Teaching and Learning Evaluation Tool applied to traditional classrooms

		Lecture Theatre Refer Figure 145	**Tutorial Room** Refer Figure 146	**Computer Lab** Refer Figure 147
	Furniture			
1.	It is possible for the teacher to move around the room easily and access all students equally and equitably.	1	3	3
2.	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.	1	3	2
3.	It is possible for students to conduct collaborative activities.	3	3	2
4.	It is possible to easily move the tables and chairs around	1	3	1
5.	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.	2	3	3
	Engagement			
6.	It is possible for the teacher to engage with students individually.	2	4	4
7.	It is possible for the teacher to engage with small groups of students.	3	4	2
8.	It is possible for the teacher to engage with the whole cohort.	5	5	5
9.	It is possible for students to interact at a 'personal' or 'social' distance as tasks are being established.	4	5	3
10	It is possible for students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance.	4	5	3
11.	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.	2	4	2
12.	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.	1	2	2
	Technology			
13.	It is possible for the teacher and students to access the same educational technologies (such as digital screens)	1	1	4
14.	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc	1	2	4
15.	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.	3	3	3
16.	It is possible for student groups to equitably access educational technologies	1	1	2
17.	It is possible for students to access resources relevant to their needs.	2	2	4
	Pedagogy			
18.	It is possible for students to work at their own pace during class.	2	4	4
19.	It is possible for students to undertake focused tasks during class.	3	4	4
20.	It is possible for students to engage in different activities at the same time.	2	4	4
21.	It is possible for students to utilise vacant floor space for learning activities (active floor).	1	2	1
22.	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.	2	3	3
23.	It is possible for students to undertake learning activities that are relevant to them and their learning context.	2	3	3
24.	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.	1	1	3
25.	It is possible for students to present their work to the teacher and the entire class for feedback.	3	4	4
	Total points out of 125	**53**	**78**	**75**
	Efficacy Rating	**42%**	**62%**	**60%**

10.5 A SIMPLE AND EFFECTIVE EVALUATION TOOL

As has been reported throughout this study, previous examples of evaluation methods have been overly complicated to implement, resulting in the need for specialist facilitators and ultimately very little application (Lee & Tan, 2011; Pearshouse et al., 2009; Radcliffe et al. 2009). Consequently, universities have continued to invest in NGLEs without compelling data to support their pedagogical value. Despite the identified benefits of adopting post occupancy evaluation there has been an acknowledged shortfall in collecting valuable data (Imms, Cleveland & Fisher, 2016).

The Effective Teaching and Learning Evaluation Tool as detailed in this chapter offers a remedy to this conundrum. Furthermore, the tool offers a multitude of uses that present benefits to the wider university community.

<u>For the University:</u>

Responding to the 25 possibility statements takes between 5 – 10 minutes. You don't have to be a teacher to respond to the statements. Therefore, facility managers within universities can manage the post occupancy evaluation process themselves, or even better, can encourage students to evaluate the classrooms. It is quick, easy and effective to use as a post occupancy evaluation tool. Facility managers and other stakeholders can collect NGLE evaluation data across multiple spaces and time, to feed into a continual improvement cycle. Identified improvements can then be applied rapidly to future refurbishment or new building opportunities.

<u>For teachers:</u>

Teachers may use the Effective Teaching and Learning Spatial Framework and/or Evaluation Tool to plan their future teaching and learning encounters by:

– Using the effective teaching and learning behaviours as a cue for learning activities to be enabled; and
– Prompting teachers to consider the spatial characteristics within the environment that will support and foster effective teaching and learning.

<u>For students:</u>

Students can participate in the post occupancy evaluation process and provide data that will be highly valued by universities. The Evaluation Tool is easy to build online, meaning that students could implement the evaluation using their own device, while experiencing the NGLE.

For architects and designers:

Architects and designers may use the effective teaching and learning behaviours and spatial characteristics as a checklist for designing a NGLE. It also serves to raise awareness of the behaviours that constitute effective teaching and learning. Increasing awareness among architects and designers will likely lead to improved versions of NGLEs over time.

Therefore, not only is the *Effective Teaching and Learning Evaluation Tool* a simple, easy-to-use instrument for evaluating NGLEs, it is a diverse tool that can be used by teachers, students, architects and designers, with the dual objectives of improving the design of NGLEs and the quality of teaching and learning on campus.

10.6 CONCLUSIONS

In this chapter the Effective Teaching and Learning Spatial Framework has been adapted to generate the Effective Teaching and Learning Evaluation Tool, by converting teaching and learning behaviours into possibility statements. The 25 possibility statements are each evaluated on a five point Likert Scale to generate an efficacy rating. The case study NGLEs examined in this study were evaluated using the new tool and four out of the five NGLEs achieved an efficacy rating of over 80%. A range of traditional classrooms were also evaluated through the same lens. The lecture theatre achieved 34% whereas the tutorial room and computer lab achieved 54% and 57% respectively.

Therefore the following conclusions have been made:

1. When classrooms are designed with spatial characteristics that are aligned with effective teaching and learning behaviours, the resultant classroom is likely to be symptomatic of a new generation learning environment.
2. The Effective Teaching and Learning Evaluation Tool measures the possibility of effective teaching and learning behaviours being enacted. Therefore, it can be used independently of the teaching and learning encounter, through the use of images that demonstrate the spatial characteristics.
3. NGLEs should achieve an efficacy rating of 80% or above.
4. NGLEs provide the best opportunity for teachers to adopt an effective teaching and learning approach and for students to experience effective teaching and learning.

5. Traditional classrooms such as lecture theatres, tutorial rooms and computer labs are not as effective as NGLEs for implementing effective teaching and learning practices.
6. If a university's objective is to increase the quality of teaching and learning on campus, then one strategy would be to increase the number of NGLEs on campus, in order to promote uptake of effective teaching and learning practices.

The final chapter will explore advances in the design of new generation learning environments since their emergence in the early 2000s, the evolution of NGLEs as an accepted space typology within university vernacular and how recent examples of NGLEs have rated using the Effective Teaching and Learning Evaluation Tool.

Chapter 11: The Evolution of NGLEs: Discussion and Conclusion

11.0 INTRODUCTION

The previous chapter demonstrated how the Effective Teaching and Learning Spatial Framework has been used to generate the Effective Teaching and Learning Evaluation Tool, a simple mechanism any interested individual or group can use to evaluate the pedagogical effectiveness of any classroom environment. As explained in the prologue, the author of this study moved from academia into a private architectural practice in 2010, with a specific focus on designing NGLEs for universities. This presented the opportunity to not only test and apply the Effective Teaching and Learning Spatial Framework and Evaluation Tool to the design of NGLEs, but to gain greater exposure to university procurement and other factors influencing their development. Rather than looking through the lens of one single university (in academia), the author has worked with several universities across Australia. This chapter outlines the evolution of NGLEs and their development as an established classroom typology on campus.

As reported in this study, the earliest example of NGLEs were often initiated by academics who acknowledged the need for a different type of classroom typology in which to practice student-centred learning. These academics presented and published their positive experiences, raising awareness of this new space typology and the emergence of a new learning space discourse. As the discourse progressed, and as has been chronicled in Chapter 2, facility managers, architects and designers shared new examples of NGLEs through professional organisations such as TEFMA (Tertiary Education Facility Management Association), CEFPI (Council for Educational Facility Planners International) and SCUP (Society of College and University Planning). The increasing number of NGLE examples resulted in learning environments becoming the focus of government funding, with a spotlight on evaluation (ALTC, 2011, Radcliffe, 2008, Lee and Tan, 2011).

In Australia, the ongoing development of NGLEs paralleled the federal government's 2011 initiative (and updated in 2015) to improve the quality of teaching and learning in higher education through the Tertiary Education Quality and Standards Agency (TESQA) Higher Education Standards (HES) Framework (Australian Government, 2017). The HES Framework presents seven 'domains', explicitly stating it is the responsibility of each university to deliver a high quality student experience. 'Domain 2: Learning Environment' outlines the expected impact on infrastructure, stating that "the onus is on the provider to demonstrate to TEQSA that its facilities and infrastructure support students to achieve the expected learning outcomes. Irrespective of the chosen mode of delivery, the Standards require a provider to offer opportunities for students (including international students) to interact outside of formal teaching, for example, group work, team building, informal learning” (Australian Government, 2017, Domain 2). Therefore, there appears to have been a convergence of ambition to improve the quality of teaching and learning at universities, through the HES Framework and procurement of appropriate infrastructure, including the development of NGLEs.

11.1 THE 21ST CENTURY STUDENT LEARNING EXPERIENCE

Since the early 2000s, the experience of being a higher education student has changed in several fundamental ways. Firstly, the competitive higher education market has resulted in universities focusing on improving student services, often providing a one-stop-shop for advice on coursework pathways, financial assistance and career advice. Secondly, mobile computing has become ubiquitous: affordable mobile technologies provides a world of constantly accessible knowledge to students. Thirdly, universities have invested heavily in digital infrastructure, such as recording and uploading lectures online, extensive digital (library) resources, and a blended coursework of face-to-face and online learning.

Notwithstanding the model of distance learning that had been in existence for decades, students face greater choices as to whether or not they need to physically attend campus, in order to access the content required to learn and achieve a higher education qualification. Students can access their lectures online instead of attending face-to-face. They can access coursework content, collaborate with peers and communicate with their lecturer online, rather than in person. As a result of the technologies available to universities and students, the notion of ‘learning anywhere and everywhere’ has prevailed (Martin, McGill & Sudweeks, 2013; Martin & Ertzberger, 2016; and Keengwe, 2018).

Perhaps the most significant consequence of this new student paradigm has been the decline in student attendance at lectures. While universities do not publish this type of data, it is well known that many students attend their timetabled lectures for the first few weeks of semester but then stop attending in deference to accessing the recorded version online. A spike in attendance at the end of semester coincides with tips by the lecturer on exam content. This conundrum has left universities frustrated by the subsequent underutilisation of lecture theatres and questioning why students come to campus at all.

However, students have continued to come to campus. The social dimension of learning (Marton et al, 1997, Prosser & Trigwell, 1999, Skinner, 2010) appears to thrive on campus, through the increased uptake of formal collaborative learning, access to specialist facilities and opportunities to interact with peers. Online learning platforms and even social media have empowered online interaction and collaboration, but face-to-face contact remains vital. The benefits of coming to campus have been described by lecturer Jason Lodge as the "opportunity to be immersed in an intellectual culture...exposure to legitimate expertise in a disciplinary area and the ability to test out new knowledge with peers" (Lodge, 2014, paragraph 14)

Over the last 15-20 years industry feedback to universities has identified a gap in student graduate skills. Students were completing courses with excellent results but lacking the transference to a practical application of skills. Industry bodies sought graduates who could thinking critically, solve problems and work in teams, subsequently labelled 'soft skills'. For example, Engineers Australia has influenced the delivery of engineering courses within many universities, through the introduction of collaborative learning, problem-based learning and other methods of developing students' 'soft skills' (Bradley, 2006).

This is where the role of NGLEs has filled a critical gap in the university experience. NGLEs have enabled the implementation of pedagogies in which students can develop these 'soft skills'. For example, the Engineering PBL studios at Victoria University (Chapter 8) were conceptualised and built to enable students to develop 'soft skills' and therefore be better prepared to enter the engineering workforce. Not only has the shift to student-centred pedagogies – enabled by NGLEs – served to satisfy industry bodies with regard to the quality of graduates, but evidence is mounting to support the performative benefits to students when they learn in 'active classroom' (Freeman et al, 2014; Scott-Webber et al. 2013; Thai et al., 2017).

11.2 NGLES FROM THEORY TO PRACTICE

Over the last ten years, examples of NGLEs have progressed from piece-meal experiments conducted by universities, to accepted space typologies incorporated into new or refurbished infrastructure, and ultimately to being the focus of entire new buildings. In the shift from academia to practice, the author was directly involved in the design of two major refurbishments where the specific focus was to incorporate NGLEs: 1) Deakin University Geelong Waterfront Campus; and 2) UNSW Flipped Classrooms for the Australian Business School.

11.2.1 Deakin University Geelong Waterfront Campus

In 2011, Deakin University redeveloped the Geelong Waterfront campus to include a suite of NGLEs, adopting an approach to test different layouts, but essentially to enable collaborative and interactive learning. Deakin was explicitly increasing collaborative learning across the university and looking to procure new generation learning environments. The author understood this to include:

- Settings for group learning;
- Each group setting to have access to a digital screen for accessing online resources;
- Increased flexibility, such as being able to timetable two classrooms together so they could be opened up to a larger capacity when required.

Early sketches were informed by the Effective Teaching and Learning Spatial Framework, refer Figure 148. In these concepts, an entirely new classroom experience was conceptualised to invert the traditional paradigm of rows of tables facing the teacher at the front. Table configurations were explored, as well as a variety of furniture settings, active walls and wall-mounted digital screens. The ideas were applied to actual spaces within the Deakin University Geelong Waterfront campus building, constrained by physical size of rooms and impacting upon capacity. Where opportunities existed, adjacent classrooms were designed to open on to each other to increase flexibility.

A variation of example D was implemented. Instead of the rectilinear tables shown in example D, the table shapes were modified to a hexagonal shape and treated as 'island' configurations, refer Figure 149. While the room works reasonably well as a classroom for collaborative learning, the size and location of digital screens were limiting factors, as was the management of power to student devices. This will be expanded further in section 11.2.3 where the Deakin classrooms have been evaluated using the Effective Teaching and Learning Evaluation Tool.

11.2.2 UNSW Flipped Classrooms for the Australian Business School

In 2013, the author was approached by the University of New South Wales (UNSW) to design a series of 'flipped classrooms' for the Australian Business School, the first time the 'flipped classroom' concept had been implemented in an Australian university. While origins of the flipped classroom were contextualised in secondary schools (Bergmann & Sams, 2012), the higher education application of the flipped classroom assumed that lecture content would be accessed online prior to class, enabling questions and interactive activities to be implemented during class.

Therefore, the design of the classroom would need to enable collaboration, including the co-creation of content and assignment responses, access to technologies, access to writeable surfaces, occasional instruction by the teacher, student groups presenting to each other and the ability to reconfigure the room if required, refer Figure 150. The most effective design elements incorporated into the flipped classrooms included: 1) all furniture to be mobile; and 2) power accessible at the walls. This enabled students the possibility of working in groups at the wall, where the digital screen, writeable surface and power were accessible. Tables could be joined together to create different scenarios, for example a boardroom, refer Figure 151. The mobility of the tables was the key enabling feature of the room.

These classrooms received high praise from staff and students (AboutUNSW, 2014; UNSWeLearning, 2014) and were well suited to their capacities of 48 and 60 students. However, universities were beginning to question how this model of teaching and learning could be scaled up to cater for larger classes, the equivalent of large lecture theatres. This will be expanded upon in section 11.3.

11.2.3 Applying the Effective Teaching and Learning Evaluation Tool

Evaluation of the Deakin Geelong NGLE and the UNSW Flipped Classroom, using the Effective Teaching and Learning Evaluation Tool, demonstrates that both exceed the target rating of 80% efficacy, refer Table 35. The Deakin classroom scored 86%, showing some weaknesses in the technology provision. Although there are multiple digital screens located in the classroom, they are small and not directly located adjacent to each table setting. There are writeable surfaces around the walls but not located in close proximity to the table settings. The UNSW Flipped Classroom scored 98%, indicating strengths across all categories of the evaluation tool and demonstrating alignment of the physical environment with the anticipated effective teaching and learning behaviours.

The Deakin University Geelong Waterfront campus and UNSW Flipped Classrooms were still considered ‘experimental’ examples that would portend eventual large-scale investment into NGLEs by those institutions. Despite the benefits of doing so, neither Deakin University or UNSW conducted formal post occupancy evaluations that would inform future versions of NGLEs. Momentum for building NGLEs was continuing to grow and as universities began to showcase their own examples of NGLEs, more universities wanted to create their own interpretation of this new space typology.

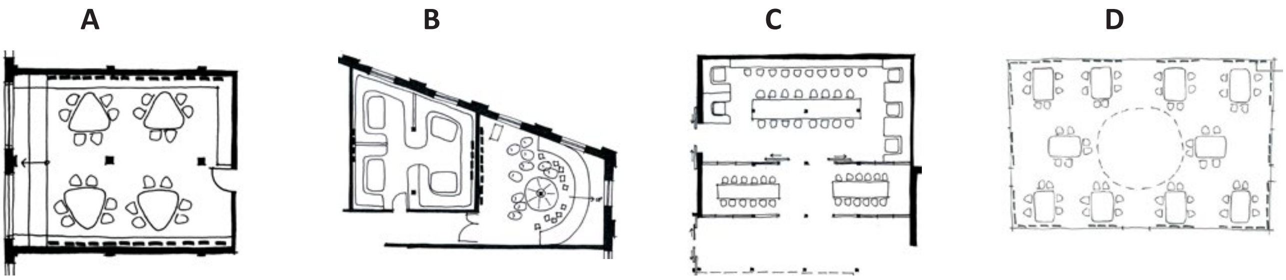

Figure 148: Early sketches of NGLEs at Deakin University Geelong Waterfront Campus.
Source: Author

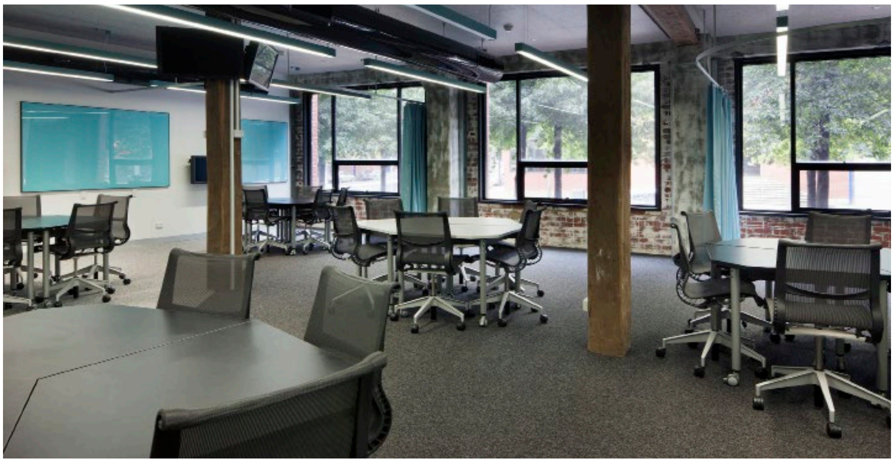

Figure 149: Deakin University Geelong Waterfront Campus NGLE Classroom
Source: Shannon McGrath

Figure 150: Flipped Classroom at UNSW, Australian Business School
Source: Jordan Spence

Figure 151: Possible configurations of the Flipped Classroom at UNSW, Australian Business School.
Source: Woods Bagot

Table 35.

Effective Teaching and Learning Evaluation Tool applied to Deakin and UNSW NGLEs

		Deakin Geelong	UNSW Flipped Classroom
	Furniture		
1.	It is possible for the teacher to move around the room easily and access all students equally and equitably.	5	5
2.	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.	4	5
3.	It is possible for students to conduct collaborative activities.	5	5
4.	It is possible to easily move the tables and chairs around	4	5
5.	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.	4	5
	Engagement		
6.	It is possible for the teacher to engage with students individually.	4	5
7.	It is possible for the teacher to engage with small groups of students.	5	5
8.	It is possible for the teacher to engage with the whole cohort.	5	5
9.	It is possible for students to interact at a 'personal' or 'social' distance as tasks are being established.	5	5
10	It is possible for students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance.	5	5
11.	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.	5	5
12.	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.	3	5
	Technology		
13.	It is possible for the teacher and students to access the same educational technologies (such as digital screens)	3	5
14.	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc	3	5
15.	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.	3	3
16.	It is possible for student groups to equitably access educational technologies	4	5
17.	It is possible for students to access resources relevant to their needs.	3	5
	Pedagogy		
18.	It is possible for students to work at their own pace during class.	5	5
19.	It is possible for students to undertake focused tasks during class.	4	4
20.	It is possible for students to engage in different activities at the same time.	5	5
21.	It is possible for students to utilise vacant floor space for learning activities (active floor).	5	5
22.	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.	5	5
23.	It is possible for students to undertake learning activities that are relevant to them and their learning context.	5	5
24.	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.	4	5
25.	It is possible for students to present their work to the teacher and the entire class for feedback.	5	5
	Total points out of 125	**108**	**122**
	Efficacy Rating	**86%**	**98%**

11.3 EVALUATING FURTHER EXAMPLES OF NGLES

11.3.1 RMIT Swanston Academic Building

In 2012, RMIT invested in a new building by Lyons Architects, known as the Swanston Academic Building (SAB). This building incorporated a variety of learning spaces labelled as interactive lecture theatres, interactive tutorial rooms, project-based spaces and several specialist business-oriented labs. The project also introduced the concept of the 'lectorial' space, in which teacher and students could seamlessly oscillate between lecture and tutorial activities, refer Figures 152 & 153.

These lectorial spaces enable a scaling up in capacity to 90 and 120 respectively. They facilitate collaborative learning and for the teacher to move between the table settings, communicating with students individually or within their groups. It is possible for the teacher to shift between delivering instructional content (that is, a lecture) and facilitating small group discussion. However, groups do not have access to technologies (apart from their own devices) and the small number of writeable surfaces appear to support only the group settings in closest proximity. It appears that the larger the scale of the classroom, the more difficult it is to navigate equitable access to technologies and writeable surfaces.

The project rooms however, were designed for smaller capacities of 30 or 60, with collaborative settings for 6 people at each table. These classrooms are more representative of NGLEs, with multiple wall-based screens for group use and, where the design of the room supported, access to writeable surfaces around the room.

The Effective Teaching and Learning Evaluation Tool was applied to three of the RMIT space typologies in the Swanston Academic Building, resulting in a wide range of efficacy ratings. The interactive lecture theatre scored 45% and demonstrated significant pedagogical and technology weaknesses. Despite the intentions of greater interactivity between students, the fixed nature of furniture all facing the teacher at the front makes interaction very limited. Students do not have access to technologies within the room, apart from their own devices. The classroom establishes a pedagogical situation in which the teacher is likely to be the dominant force in the room. Therefore, pedagogically the interactive lecture theatre cannot be classified as a NGLE.

The lectorial classroom scored 73% with weaknesses relating to student access to technology. Collaborative learning is possible, however the fixed nature of the table settings and inequitable access to

Figure 152: Plan of 60 capacity Lectorial Theatre,
RMIT Swanston Academic Building.
Architects: Lyons Architecture
Source: Lyons Architecture

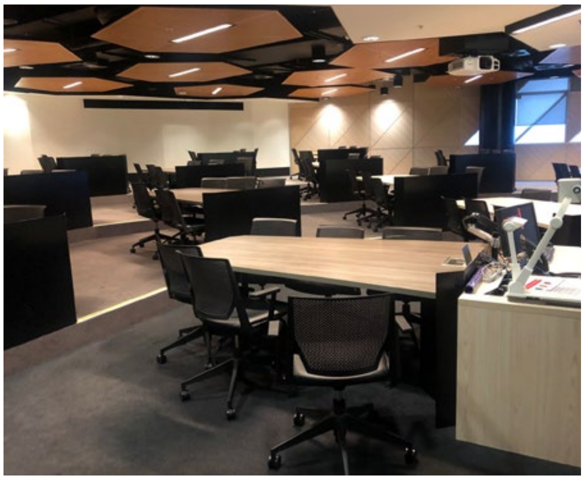

Figure 153: Image of 60 capacity Lectorial Theatre,
RMIT Swanston Academic Building.
Architects: Lyons Architecture
Source: Author

Figure 154: Plan of 240 capacity Interactive Theatre,
RMIT Swanston Academic Building
Architects: Lyons Architecture
Source: Lyons Architects

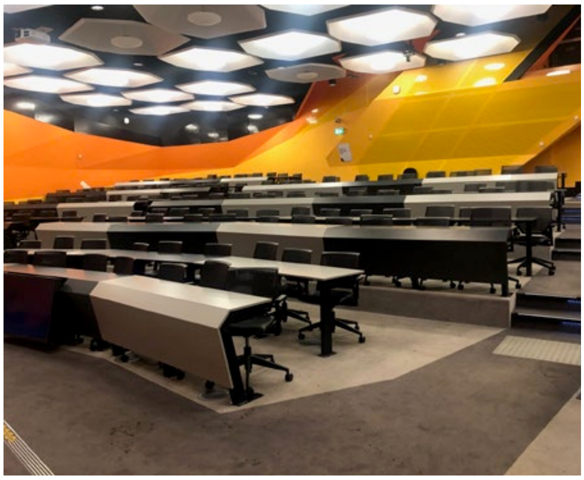

Figure 155: Imageof 240 capacity Interactive Theatre,
RMIT Swanston Academic Building.
Architects: Lyons Architecture
Source: Author

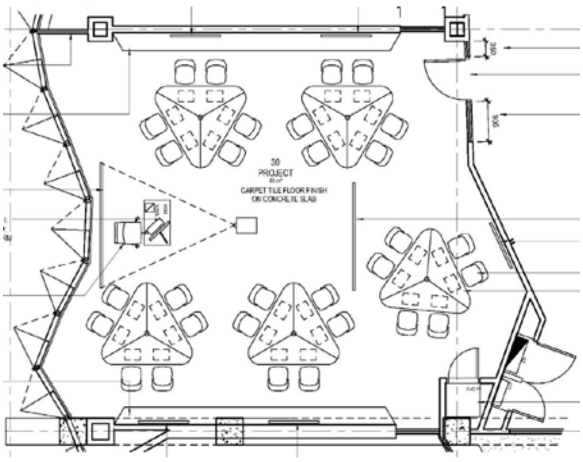

Figure 156: Plan of 30 capacity Project Room,
RMIT Swanston Academic Building
Architects: Lyons Architecture
Source: Lyons Architects

Figure 157: Image of 30 capacity Project Room,
RMIT Swanston Academic Building.
Architects: Lyons Architecture
Source: Author

Table 36.

Effective Teaching and Learning Evaluation Tool applied to RMIT Swanston Academic Building classrooms.

		Interactive Theatre	Lectorial	Project Room
	Furniture			
1.	It is possible for the teacher to move around the room easily and access all students equally and equitably.	2	4	5
2.	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.	1	2	5
3.	It is possible for students to conduct collaborative activities.	3	5	5
4.	It is possible to easily move the tables and chairs around	1	2	5
5.	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.	2	3	4
	Engagement			
6.	It is possible for the teacher to engage with students individually.	2	4	5
7.	It is possible for the teacher to engage with small groups of students.	3	5	5
8.	It is possible for the teacher to engage with the whole cohort.	5	5	5
9.	It is possible for students to interact at a 'personal' or 'social' distance as tasks are being established.	4	5	5
10	It is possible for students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance.	4	5	5
11.	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.	2	5	5
12.	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.	1	2	4
	Technology			
13.	It is possible for the teacher and students to access the same educational technologies (such as digital screens)	1	3	2
14.	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc	1	3	4
15.	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.	3	3	3
16.	It is possible for student groups to equitably access educational technologies	1	1	4
17.	It is possible for students to access resources relevant to their needs.	2	3	4
	Pedagogy			
18.	It is possible for students to work at their own pace during class.	3	4	4
19.	It is possible for students to undertake focused tasks during class.	3	4	4
20.	It is possible for students to engage in different activities at the same time.	2	5	5
21.	It is possible for students to utilise vacant floor space for learning activities (active floor).	2	2	3
22.	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.	2	4	4
23.	It is possible for students to undertake learning activities that are relevant to them and their learning context.	2	4	5
24.	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.	1	3	3
25.	It is possible for students to present their work to the teacher and the entire class for feedback.	3	5	5
	Total points out of 125	**56**	**91**	**108**
	Efficacy Rating	**45%**	**73%**	**86%**

writeable surfaces, means this space typology cannot be classified as a NGLE. The project room, however, scored 86% and can be classified as a NGLE. Student groups can access wall-based technologies, sit within group settings and effective teaching and learning behaviours are clearly possible.

Therefore, the interactive lecture theatre and lectorial classroom, both of which were designed to accommodate large numbers of students, have failed to align with the definition of a NGLE. This highlights the difficulty of trying to design too much flexibility into classroom typologies. NGLEs appear to be difficult to design for a large capacity of students (that is, above 60 students) without compromising access to wall-based technologies and enabling an authentic collaborative experience.

11.3.2 Monash University Learning & Teaching Building, Clayton Campus

Monash opened a new building on its Clayton campus in 2018, designed by John Wardle Architects, known as the Learning & Teaching Building (LTB). It comprises a series of different capacity NGLEs, three interactive lecture theatres and a novel circular classroom. The interactive lecture theatres and circular classroom have been designed for the flexibility of enabling focused lectures and collaborative learning to a capacity of 150- 240 students, refer Figures 159 & 160. Two of these interactive classrooms enable students to sit in groups, with access to local technologies, writeable surfaces and power. The largest interactive theatre does not enable students to sit in groups, but two rows of seats and desks per row make it possible for students to conduct interactive tasks during class.

The circular theatre (refer Figure 160.) provides all of the required characteristics to be classified as a NGLE, achieving a capacity of 150 students. The technology system enables content to be projected to local screens. Each table setting has an allocated section of wall for whiteboard and projection. Using the Effective Teaching and Learning Evaluation Tool (Table 38), the circular theatre scores an efficacy rating of 93%, considerably higher than the interactive lecture theatres (61%).

How do these newer examples of NGLEs differ from early examples? What has been learned from the early examples? What are the key challenges to the implementation of future NGLEs? These questions will be explored in the next section.

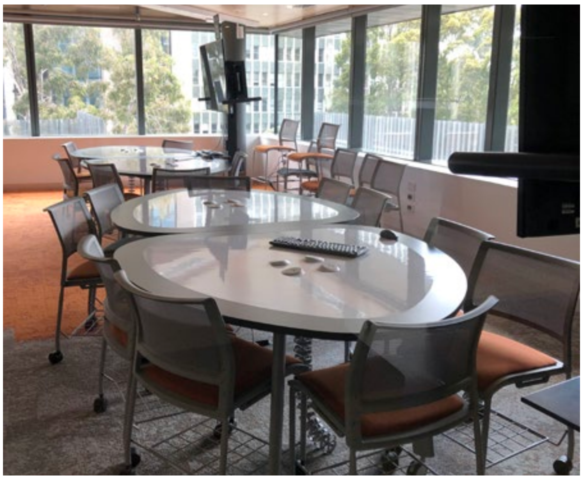

Figure 158: Image of NGLE, Monash University Clayton Campus, Learning & Teaching Building
Architects: John Wardle Architects
Source: Author

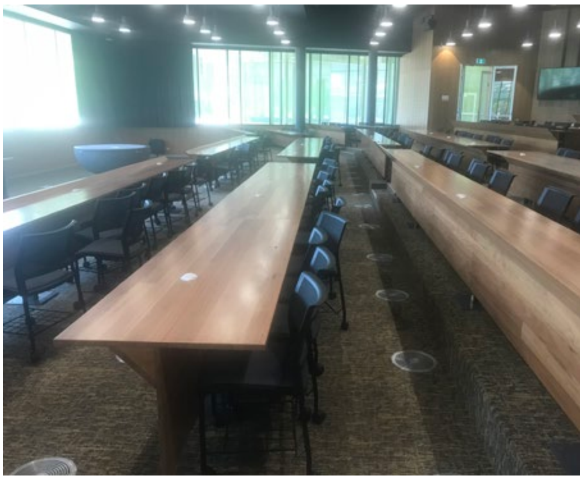

Figure 159: Image of Interactive Theatre, Monash University Clayton Campus, Learning & Teaching Building
Architects: John Wardle Architects
Source: Author

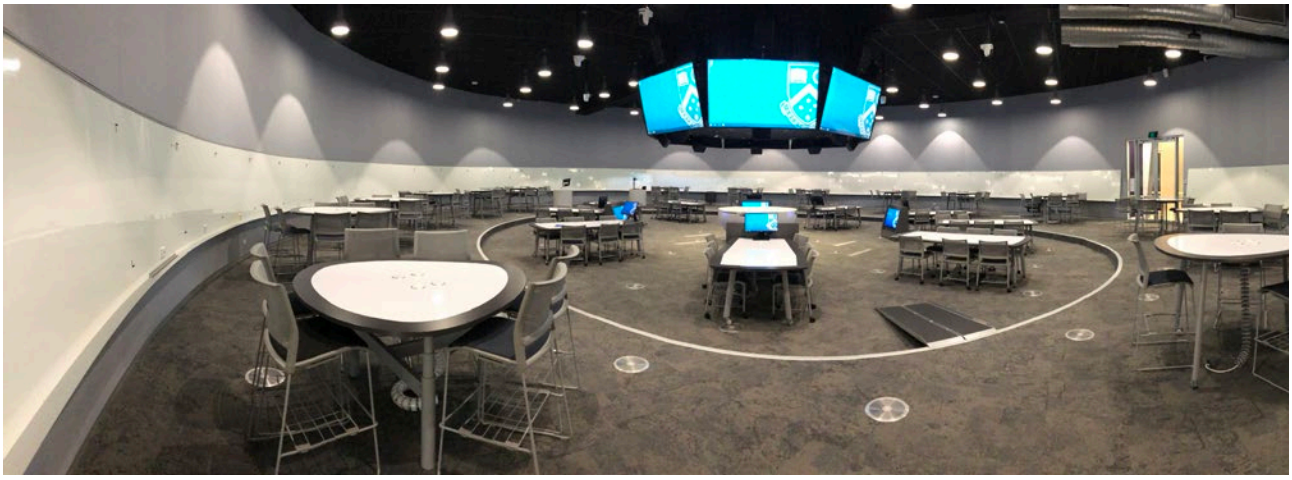

Figure 160: Image of Circular Theatre, Monash University Clayton Campus, Learning & Teaching Building
Architects: John Wardle Architects
Source: Author

Table 37.

Effective Teaching and Learning Evaluation Tool applied to Monash University LTB.

		NGLE	Interactive Theatre	Circular Theatre
	Furniture			
1.	It is possible for the teacher to move around the room easily and access all students equally and equitably.	5	4	5
2.	It is possible for students and teachers to manipulate the physical environment to access appropriate resources and environmental conditions.	3	1	3
3.	It is possible for students to conduct collaborative activities.	5	3	5
4.	It is possible to easily move the tables and chairs around	3	1	3
5.	It is possible for the teacher to meet individually and/or privately with students to provide direct feedback.	4	3	5
	Engagement			
6.	It is possible for the teacher to engage with students individually.	5	4	5
7.	It is possible for the teacher to engage with small groups of students.	5	4	5
8.	It is possible for the teacher to engage with the whole cohort.	5	5	5
9.	It is possible for students to interact at a 'personal' or 'social' distance as tasks are being established.	5	5	5
10	It is possible for students to move around to initiate full engagement of tasks at a 'personal' or 'intimate' distance.	5	4	5
11.	It is possible for different students to undertake activities at different levels of engagement and at varying distances, simultaneously in the classroom.	5	3	5
12.	It is possible for student groups to display the product of their interactions and discussion for the teacher and other students to see.	2	1	5
	Technology			
13.	It is possible for the teacher and students to access the same educational technologies (such as digital screens)	4	2	5
14.	It is possible for students to utilise learning resources including the available technologies, e.g. whiteboard, digital screen, document camera, internet, computer/tablet, etc	4	4	5
15.	It is possible for students to capture content presented by the teacher and/or the product of interactions with other students.	3	3	3
16.	It is possible for student groups to equitably access educational technologies	4	1	5
17.	It is possible for students to access resources relevant to their needs.	4	3	5
	Pedagogy			
18.	It is possible for students to work at their own pace during class.	4	3	5
19.	It is possible for students to undertake focused tasks during class.	4	3	4
20.	It is possible for students to engage in different activities at the same time.	5	4	5
21.	It is possible for students to utilise vacant floor space for learning activities (active floor).	4	3	4
22.	It is possible for the teacher to adapt their teaching approach in response to different student cohorts based upon their prior learning experiences.	4	2	4
23.	It is possible for students to undertake learning activities that are relevant to them and their learning context.	5	4	5
24.	It is possible for the teacher to visually scan the room to monitor students, evaluate progress and effectively identify students who may need assistance.	3	1	5
25.	It is possible for students to present their work to the teacher and the entire class for feedback.	5	5	5
	Total points out of 125	**105**	**76**	**116**
	Efficacy Rating	**84%**	**61%**	**93%**

11.4 LEARNING FROM PAST EXAMPLES OF NGLES TO IMPLEMENT INTO FUTURE NGLES

The most recent versions of NGLEs look considerably different compared to the case study examples reported in this study. Furniture settings, group size, transparency and technology are all variables that have evolved with time. The pedagogy-technology-space nexus as highlighted by Radcliffe et al (2008), has remained as relevant now as it was then. The next section highlights three key issues that continue to present challenges in the design of NGLEs. They are: 1) group size; 2) collaborative furniture settings; and 3) access to power.

11.4.1 Group size

The design of NGLEs has developed in understanding the ideal group size for collaborative learning. When the large NGLEs located in the CTLC at the University of Queensland were conceptualised, the size of groups was conceived to include as many as 18 people (refer Chapter 6). This seems unviable now, but at the time neither the educators or the architect for the CTLC were aware of the ideal group size. Since the CTLC was built, Barkley, Major and Cross (2014) and Thompson et al (2015) have published their findings that group size should be no more than seven people.

The Learning Lab at the University of Melbourne was conceptualised with a more rigid framework for collaborative learning (refer Chapter 7). Table settings were designed to enable five groups of eight people, which could be further broken down to ten groups of four people. This seemed a logical approach, except that teachers interviewed for this study expressed that they did not attempt to instruct students to work in specific group sizes. Observations revealed that students self-organised into smaller groups of two or three people. It is understood that the group size was not a key focus of professional development in the Learning Lab, hence leaving each teacher to manage collaboration differently.

Examples of contemporary NGLEs have incorporated group settings of 5 – 8 people, indicating that there is some consensus regarding group size and the design of NGLEs.

11.4.2 Collaborative furniture settings

The furniture settings to support collaborative learning in NGLEs continue to be a topic of ongoing discussion. What is the right size and shape of table to optimise the collaborative learning experience? There are three standard shapes that have become popularly tested within NGLEs: circular/hexagon, rectilinear and plectrum, refer Figure 161.

Circular tables are versatile to a degree; it is easy to fit 6 – 8 people around a single table. However, if the size of the table is too large (a common design fault) it is difficult for participants on opposite sides of the circle to interact. Circular tables are best suited to island settings, not to be located adjacent walls, which then questions how best to access technologies such as digital screens and writeable surfaces, as well as how best to manage access to power. Hexagonal tables are very similar to circular tables and attract all of the same issues. The main difference between a hexagon and circular table is that a hexagon table may be joined up with other hexagon tables to create different configurations.

Plectrum-shaped tables suit group sizes of six people, with no more than two people along each side. Care needs to be taken to size the table so as to maintain easy interaction between all participants. As with circular and hexagon tables, plectrum tables are suited to an island configuration and the subsequent issues in relation to access to power and wall-mounted technologies.

Rectilinear tables offer greater flexibility in that they can be used in island settings or adjacent to walls. They can also be reconfigured with other rectilinear table in a variety of settings. There are proprietary versions of rectilinear tables that promote full mobility and flipping of the table-top to enable efficient storage. One weakness occurs when locating a rectilinear table adjacent a wall-mounted digital screen. When docked directly to the wall (to access power for example), the people situated closest to the wall are likely to be located too close to the digital screen, with poor line of sight. The table length needs to be elongated to compensate, or, as was instigated in the UNSW Flipped Classrooms, the sides of the rectilinear tables were tapered so as the widest end of the table was docked against the wall. This enabled the people situated closest to the wall to be distanced a little further from the screen, with better line of sight. The tapered rectilinear table can also be reconfigured into a variety of settings, as was also demonstrated in the UNSW Flipped Classroom, refer Figure 148.

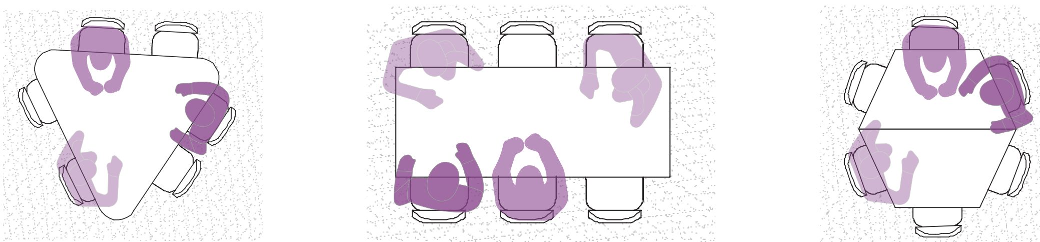

Figure 161: Common table shapes for collaborative learning
Source: Woods Bagot

Some of the case study examples demonstrated other table shapes that have not evolved further since their implementation. For example, the small kidney-shaped tables in the smaller CTLC classrooms at the University of Queensland and the butterfly-shaped tables in the Learning Lab at the University of Melbourne. The kidney-shaped tables were adequate for small groups of up to four people but were not possible to reconfigure into larger settings, hence did not provide enough flexibility. The butterfly tables were made up of two 'wings' that pivoted around a central, fixed column. Notwithstanding the location of a fixed PC on each wing, the combined size of the two wings made it difficult for people on opposite sides to interact easily. This setting was permanently fixed and also offered little flexibility. However, as furniture experiments, these examples provided important observations to impact future NGLE developments.

While many furniture configurations have been tested within NGLEs, the selection of table shape and size is dependent upon a number of factors: group size, capacity of the room, type of technologies to access, strategy to access power and the need to reconfigure tables into alternative settings. These factors need to be considered within the context of each NGLE.

11.4.3 Access to power

The mobility of technologies carried by students into NGLEs has resulted in high demand for general power outlets (GPOs), to enable recharging. Even though battery life of laptops is much longer than ever before, students inevitably need to plug in their devices throughout the day. If GPOs are not conveniently positioned, students will use any available GPO, often resulting in the precarious positioning of leads and the creation of trip hazards. Therefore, this is an issue not to be ignored and has significant consequences for the design of NGLEs.

Power via GPOs typically comes from one of three sources: ceiling, floor or wall. GPOs can be hung from the ceiling via flexible cables, although in a classroom of 30 or more students, providing enough power outlets would result in an undesirable forest of ceiling-hung cables. New buildings can have flush mounted GPOs embedded within the concrete slab, or in special circumstances may be located within a raised floor. However, the location of GPOs in a concrete slab are permanent, limiting future flexibility and rearrangement of the classroom. Students inevitably end up on the floor, scrambling to plug in their devices. Some tables have in-built GPOs at the table surface and are connected to the floor box, but this also results in the table location being fixed and limiting future flexibility. The refurbishment of existing buildings often limits the positioning of floor-mounted power boxes and almost certainly prevents flush-mounted boxes from being installed.

Walls on the other hand, provide greater flexibility, with GPOs able to be installed anywhere on a standard solid partition. However, table settings need to be located adjacent to the wall in order to optimise their use. The capacity of the class may limit the ability to have each group setting located adjacent a wall, especially where glazed walls are located. That is, a large NGLE with a capacity of 60 students requires a lot of wall space to ensure at least ten tables can be located adjacent a wall. The large flipped classrooms at UNSW (capacity of 60) were designed for each of the ten group tables to be 'docked' to an adjacent wall, refer Figure 150. This was a highly successful characteristic of this NGLE, but difficult to implement for a larger capacity. The circular classroom in the LTB at Monash University is the only known exception. With a capacity of 150 students, the spaciousness and circular shape of the room maximises wall space that can be accessed by each group, refer Figure 160.

Therefore, there is a tension between providing accessible (and plentiful) GPOs and the future flexibility of the NGLE. While locating GPOs on solid vertical partitions provides considerable flexibility, it may limit the capacity of the room. Tables with embedded GPOs (via the floor) are effective as long as there is no need to move the furniture. This solution can be applied to NGLEs with a requirement for large capacity. There is no simple solution to optimum power supply and this needs to be carefully addressed on a case-by-case basis, in tandem with capacity of the room and design of the furniture settings.

11.4.4 Summary

Each of the contemporary NGLEs at Deakin University, RMIT and Monash University have been analysed for alignment with the six spatial characteristics in the Effective Teaching and Learning Spatial Framework, refer Table 38. The notion of the interactive lecture theatre or lectorial space as a space typology that enables a seamless transition between lecture and tutorial activities fails to deliver effective teaching and learning as they appear to promote a teacher-centric experience. While they address some university concerns regarding teaching and learning for large capacity classes, they fall short against almost every criteria when compared to new generation learning environments.

Not all NGLEs have explored a variety furniture settings, although where the opportunity has presented, furniture variety has been included. For example, the UNSW Flipped Classrooms tested two unique variations. While all the tables were designed to the same shape and size, some tables were positioned at a low height (to include people in wheelchairs) and others were located at a standing height (with stools provided). In one of the large Flipped Classrooms, two group settings were located on a higher platform. The group settings were identical to those on the floor level, but the higher platform offered slightly longer sight lines across the classroom. This gesture was not a necessity to improve functionality of the room, but rather to offer a different perspective for students.

Despite the variations in design of more recent NGLEs, the spatial characteristics identified in the early case studies are still relevant. Therefore, the Effective Teaching and Learning Spatial Framework (Table 38) continues to offer a useful guide for designing future NGLEs. The unique context of each NGLE breeds variety into room capacity, table configurations and access to educational technologies. This means that a one-size-fits-all approach to designing NGLEs is unlikely to succeed. Each NGLE should be designed in relation to its context and specific educational requirements.

11.5 NGLES AS A SUSTAINED CLASSROOM TYPOLOGY

The language of classroom infrastructure has demonstrably changed in recent years, especially among Australian universities. With each project brief to design a new or refurbished educational building, it is now common to see requests to incorporate NGLEs, described vicariously as ‘collaborative’, ‘flexible’ or ‘active’ classrooms, rather than tutorial rooms, seminar rooms or computer laboratories. It is a criticism of Australia’s Tertiary Education Facility Managers Association (TEFMA) that they have not updated their *Space Planning Guidelines* since 2009. Despite the advancement of NGLEs as an acknowledged key classroom typology on university campuses, and TEFMA’s role in promoting the emergence of NGLEs, there is no reference to them in the 2009 edition of the Guidelines. Promises of an imminent upgrade to the Guidelines have failed to deliver.

University Strategic Plans commonly reference their commitment to providing student-centred or active learning experiences on campus. For example, Swinburne University of Technology’s *Strategic Plan 2025* states that “Transforming learning strategy spans from refreshing curriculum, to fostering active learning and supporting employability outcomes” (Kristjanson, 2017). Monash University’s *Strategic Plan 2015 – 2020* states they “will support the best in pedagogy and flexible delivery through contemporary

Table 38.

Comparison of Effective Teaching and Learning Spatial Characteristics

	Effective Teaching and Learning Spatial Characteristics					
New Generation Learning Environments and Interactive Lecture Theatres	**Spaciousness**	**Mobile furniture**	**Group furniture settings**	**Variety of furniture settings**	**Accessible educational technologies**	**Active Surfaces**
Deakin Immersive Learning Environment (DILE)	✓	✓	✓	✓	✓	✗
University of Melbourne Learning Lab	✓	✗	✓	✓	✓	✓
University of Queensland CTLC Large	✓	✗	✓	✓	✓	✗
University of Queensland CTLC Small	✓	✓	✓	✓	✓	✓
Victoria University PBL Studios	✗	✗	✓	✓	✓	✓
Deakin University Geelong Waterfront Campus NGLEs	✓	✓	✓	✓	✓	✓
UNSW Flipped Classrooms	✓	✓	✓	✓	✓	✓
RMIT Swanston Academic Building (SAB) Interactive Lecture Theatre	✓	✗	✗	✗	✗	✗
RMIT Swanston Academic Building (SAB) Lectorial	✓	✓	✓	✗	✗	✗
RMIT Swanston Academic Building (SAB) Project Room	✓	✓	✓	✗	✓	✓
Monash University NGLE	✓	✓	✓	✓	✓	✓
Monash University Learning & Teaching Building Interactive Theatre (240P)	✓	✗	✗	✗	✗	✗
Monash University Learning & Teaching Building Circular Theatre	✓	✓	✓	✓	✓	✓

technologies and learning spaces and effective management of our education" (Gardner, 2015).

Despite TEFMA's outdated *Space Planning Guidelines*, there are positive signs that Universities are embracing high quality education programs that incorporate student-centred pedagogies, enabling students to develop a range of valued soft skills. As has been demonstrated throughout this study, these high quality student learning experiences are more effectively undertaken within NGLEs, which have been purposely designed to enable effective teaching and learning behaviours. It appears, therefore, that new generation learning environments are here to stay.

11.6 FUTURE RESEARCH

11.6.1 Evaluation

Although tremendous advances have been achieved in the development of NGLEs within the last twenty years, there are still critical research questions to be answered. Research into the evaluation of NGLEs, as outlined in Chapter 2, appears to have stalled. Evaluation of past NGLEs has been fraught with complex methodologies and costly implementation (Imms et al. 2016; Lee & Tan, 2011; Pearshouse et al. 2009). It has also been difficult to uncouple the positive benefits of implementing student-centred pedagogies from the benefits of utilising new generation learning environments. Does a student-centred pedagogical approach, on its own, lead to better student outcomes? Or is this inextricably linked to being enabled within the right type of environment? Perhaps the most important question to ask in relation to NGLEs is whether or not student-centred learning, or effective teaching and learning, is actually possible?

The Effective Teaching & Learning Evaluation Tool, presented in this thesis, offers a method for answering this last question. By focusing on the 'possibility' of effective teaching and learning taking place, the design of the new generation learning environment is separated from the actual teaching and learning taking place. We know that some teachers will use NGLEs to practice in traditional teacher-centred ways, but this should not diminish the evaluation of the NGLE as an exemplar classroom. The teaching practice is not being evaluated, only the potential of the environment to enable effective teaching and learning behaviours. But where to next?

11.6.2 The Student Experience

We don't know enough about the student experience of learning in NGLEs. Anecdotally we believe that students generally enjoy student-centred learning experiences. Universities collect student feedback on a range of campus experiences, but little attention is centred on specific space typologies. With the evolving changes to the 21st century student university experience (for example, blended learning, collaboration, accessible technologies and graduate attributes) more in-depth understanding of how students learn within these new contexts would be beneficial. It would be useful to know what motivates students to come to campus, especially when they may have the choice of accessing content online. Does the student perspective change according to the discipline in which they are studying? And what is the difference in perspective between a first-year student and a senior student? Answers to these questions are unlikely to be achieved through a singular survey tool. Universities will need to invest in a robust methodology that incorporates qualitative and quantitative data, including the opportunity for students to offer detailed commentary.

11.7 CONCLUSION

This thesis has traversed the longitudinal development of a new space typology in higher education, referred to as a new generation learning environment (NGLE), designed to enable effective teaching and learning. This new classroom typology differs from traditional university classroom typologies in that they foster collaboration, interaction and engagement with educational technologies. Research into student learning indicates that students benefit from opportunities to collaborate and interact with their peers, which assists them to understand new concepts and complex problems. In a world of increasingly complex problems, graduates need to develop 'soft skills' such as effective communication, critical thinking and problem solving. Therefore, the higher education landscape has changed.

The old paradigm of teaching and learning at university assumed the teacher as the expert keeper of knowledge and the student as the recipient of that knowledge. The 21st century paradigm is vastly different. Students have access to extensive knowledge in the palm of their hands, through mobile technologies and ubiquitous access to the internet. The value of the teacher has become less about being the knowledge keeper and more about being the knowledge curator, or facilitator of learning. It is within this context that the new generation learning environment has found its niche on the university campus.

Examination of the four case studies presented in chapters 5 - 8 found that NGLEs comprise several unique spatial characteristics that distinguish them from other traditional classrooms. For example, space for students to move around the room, access to the same educational technologies as the teacher and active surfaces to support collaborative learning. The critical aspect in the development of each case study NGLEs was the ability of an academic to provide an educational narrative to which an architect has been able to reinterpret the concept of the classroom.

This thesis has established two emergent constructions based upon the findings: 1) the Effective Teaching and Learning Spatial Framework (Table 27); and 2) the Effective Teaching and Learning Evaluation Tool (Table 32). The Spatial Framework was constructed as a result of previously separate but parallel disciplines: student learning research in higher education and environmental psychology. These disciplines have intersected in the Spatial Framework to reveal a series of spatial characteristics that, when applied to the design of new generation learning environments, increase the likelihood of effective teaching and learning taking place.

Chapter 10 described how the teaching and learning behaviours within the Effective Teaching and Learning Spatial Framework were extrapolated to identify 25 'possibility statements', culminating in the Effective Teaching and Learning Evaluation Tool, a device to measure the alignment of the physical classroom with effective teaching and learning processes. Consequently, the Evaluation Tool fills a gap in the learning space discourse. Where previous attempts to develop post occupancy evaluation methods resulted in overly complicated, unsustainable methodologies, the Effective Teaching and Learning Evaluation Tool is simple and easy to use. In addition to being an evaluation device, it has the dual benefit of prompting the teacher to consider the teaching and learning activities possible in the NGLE and prompting the architect or designer to consider the spatial characteristics to include in design.

Through the lens of reflecting upon the design of more recent NGLEs, it is possible to declare that new generation learning environments are having an impact on university campuses; the classroom paradigm is shifting. Universities are replacing tutorial rooms, seminar rooms, computer laboratories and even lecture theatres, with a variety of NGLEs, designed specifically to elicit a rich, meaningful student learning experience that aligns with 21st century graduate attributes.

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APPENDICES

Appendix A: Monash University Ethics Approval and Explanations

From: scerh
To: Bronwyn Stocks
Cc: p.jamieson@unimelb.edu.au; Jo Dane
Subject: Monash Human Ethics CF07/3928 - 2006/922
Date: 23 October 2007 4:02:49 PM

PLEASE NOTE: To ensure speedy turnaround time, this correspondence is now being sent by email only. If you would prefer a PDF on letterhead, please contact the Human Ethics Office (9905 2076 or scerh@adm.monash.edu.au) and a PDF will be emailed to you.

We would be grateful if first-named investigators could ensure that their co-investigators are aware of the content of the correspondence.

Dr Bronwyn Stocks
Faculty of Art and Design
Caulfield Campus

23 October 2007

CF07/3928 - 2006/922: New Generation Learning Environments for Higher Education

Dear Researchers,

Thank you for submitting your Request for Amendment form with respect to the above named project.

This is to advise that the requested amendments dated 15 October, 2007 have been approved and the project can proceed according to your approval given on 20 February 2007.

Thank you for keeping the Committee informed.

Dr Souheir Houssami
Executive Officer, Human Research Ethics (on behalf of SCERH)

Cc: Ms Jo Dane, Assoc Prof Peter Jamieson

--
Ms Coral Lindupp
Senior Administrative Officer
Human Ethics Office
Building 3E, Room 111
Monash University, Clayton 3800
Phone: 9905 2076
email: scerh@adm.monash.edu.au

MONASH University
Art & Design

EXPLANATORY STATEMENT TO ACADEMICS

This is an Explanatory Statement for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

The purpose of this research is to discuss with academics how the _____ Learning Environment, at _____ University, affects their learning experience. Academics will currently teach in the _____. _____ University has approved the methodology of this research, including the recruitment of academics by nominating those who work in the _____. The outcomes of this research will contribute to an increased understanding of how particular university facilities are designed, implemented and used by the primary university stakeholders.

Academics are invited to volunteer one hour of their time to participate in an interview with co-investigator Dane, to discuss their experience of the ______ Learning Environment.

Academics willing to participate in the interview are asked to complete the attached Consent Form (including contact details) and will be contacted to arrange a time and meeting place for the interview, within the next two weeks. Approximately 4 - 5 interviews will be conducted for the ______ Learning Environment.

The interview will be scheduled to take place at ______ University, and is intended to be relaxed and informal. The Co-Investigator will ask a series of questions relating to the academic's experiences of assisting student learning within the ______ environment and their observations of students undertaking their learning activities. For transcribing purposes only, the interview will be audio-taped, for use by the Chief and Co-Investigators as named on the Ethics Application. This discussion will take no longer than one hour. No discomfort is intended or anticipated.

Participants may withdraw from the research project at any stage without consequence and any contributions will not be used in the research project.
Participants will not be identified in the research unless consent has been provided to do so.

The results of the study will be reported in the Co-Investigator's thesis, and may also form the basis of published papers and conference presentations. Such documents will be made available on the Co-Investigator's intranet site at the time of publication; the intranet address will be provided to all participants.

Records will be stored by the Co-Investigator for five years after publication, in a locked environment, after which time the records will be destroyed. Names and contact details of participants will not be released to any person. The Co-Investigator will treat the data responsibly and use all due care and diligence to protect the privacy of all participants.

For further information regarding this research project, please contact the Co-Investigator, Jo Dane at Monash University, Faculty of Art & Design, or the Chief investigator, Dr. Bronwyn Stocks at Monash University, Faculty of Art & Design.

Jo Dane Tel. 03 9903 2751 or by email:
Jo.dane@artdes.monash.edu.au

Dr. Bronwyn Stocks Tel. 03 9903 1925 or by email:
Bronwyn.stocks@artdes.monash.edu.au

Should you have any complaint concerning the manner in which this research project 2006/922 is conducted, please do not hesitate to contact the Monash University Standing Committee on Ethics in Research Involving Humans at the following address:
Human Ethics Officer, Building 3E, Room 111
Research Office
Monash University VIC 3800
Tel: +61 3 9905 2052 Fax: +61 3 9905 1420 Email: scerh@adm.monash.edu.au

MONASH University
Art & Design

EXPLANATORY STATEMENT TO UNDERGRADUATE STUDENTS

This is an Explanatory Statement for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University:

“New Generation Learning Environments for Higher Education”

The purpose of this research is to observe and discuss with academics how the _____ Learning Environment , at _____ University, affects their teaching and learning experience. Students will be currently enrolled undergraduates who use the ________; academics will currently teach in the ________. _________ University has approved the methodology of this research, including the recruitment of academics and students who use the ______ Learning Environment.

The research investigators wish to observe students and teachers utilising the classroom environment and to photograph the learning setting, as a form of documenting the activities being observed. Students are invited to provide consent to being photographed.

The research investigators will be seeking to publish the research and request your permission to use the photographs in related publications and presentations.

Participants may withdraw from participating at any stage without consequence and any contributions made will not be used in the research project.
.
Participants will not be identified in the research unless consent has been provided to do so.

The results of the study will be reported in the Co-Investigator’s thesis, and may also form the basis of published papers and conference presentations. Such documents will be made available on the Co-Investigator’s intranet site at the time of publication; the intranet address will be provided to all participants.

Records will be stored by the Co-Investigator for five years after publication, in a locked environment, after which time the records will be destroyed. Names and contact details of participants will not be released to any person. The Co-Investigator will treat the data responsibly and use all due care and diligence to protect the privacy of all participants.

For further information regarding this research project, please contact the Co-Investigator, Jo Dane at Monash University, Faculty of Art & Design, or the Chief investigator, Dr. Bronwyn Stocks at Monash University, Faculty of Art & Design.

Jo Dane Tel. 03 9903 2751 or by email:
Jo.dane@artdes.monash.edu.au

Dr. Bronwyn Stocks Tel. 03 9903 1925 or by email:
Bronwyn.stocks@artdes.monash.edu.au

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Tel: +61 3 9905 2052 Fax: +61 3 9905 1420 Email: scerh@adm.monash.edu.au

MONASH University
Art & Design

EXPLANATORY STATEMENT TO FACILITY MANAGERS & ARCHITECTS/DESIGNERS

This is an Explanatory Statement for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

The purpose of this component of research is to discuss the process involved in the design of the _____ Learning Environment at _____ University with key personnel, including facility managers and architects/designers. The outcomes of this research will contribute to an increased understanding of how particular university facilities affect the teaching and learning experience of the primary university stakeholders. _______ University has approved the methodology of this research, including interviews with academics and interviews with facility managers and key architectural personnel.

_________ has identified you as a key person in the design and implementation of the _________ Learning Environment. Therefore you are invited to participate in an interview with co-investigator Dane, to discuss the process you experienced throughout the design and implementation of the ________ Learning Environment.

If you are willing to participate please complete the attached Consent Form (including contact details) and you will be contacted to establish an interview time and place.

The interview will be scheduled to take place at a venue convenient to you and is intended to be relaxed and informal. The Co-Investigator will ask a series of semi-structured questions relating to considerations of how the learning environment was designed to enable student learning; discussion will be encouraged. For transcribing purposes only the interview will be audio-taped, for use by the Chief and Co-Investigators as named on the Ethics Application. The interview will take no longer than one hour.

No discomfort is intended or anticipated.
Participants may withdraw at any stage without consequence and any contributions made will not be used in the research project.

The results of the study will be reported in the Co-Investigator's thesis, and may also form the basis of published papers and conference presentations. Such documents will be made available on the Co-Investigator's intranet site at the time of publication; the intranet address will be provided to all participants. At no time will any participants be identified in the research.

Records will be stored by the Co-Investigator for five years after publication, in a locked environment, after which time the records will be destroyed. Names and contact details of participants will not be released to any person. The Co-Investigator will treat the data responsibly and use all due care and diligence to protect the privacy of all participants.

For further information regarding this research project, please contact the Co-Investigator, Jo Dane at Monash University, Faculty of Art & Design, or the Chief investigator, Dr. Bronwyn Stocks at Monash University, Faculty of Art & Design.

Jo Dane Tel. 03 9903 2751 or by email:
Jo.dane@artdes.monash.edu.au

Dr. Bronwyn Stocks Tel. 03 9903 1925 or by email:
Bronwyn.stocks@artdes.monash.edu.au

Should you have any complaint concerning the manner in which this research project 2006/922 is conducted, please do not hesitate to contact the Monash University Standing Committee on Ethics in Research Involving Humans at the following address:
Human Ethics Officer, Building 3E, Room 111
Research Office
Monash University VIC 3800
Tel: +61 3 9905 2052 Fax: +61 3 9905 1420 Email: scerh@adm.monash.edu.au

MONASH University
Art & Design

CONSENT FORM FOR ACADEMIC STAFF

This is a Consent Form for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

I have had the project explained and have read the Explanatory Statement.
This project is voluntary. As a participant of this interview, I understand I can withdraw at any time without consequence and any contributions made will not be used in the research project.
I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any research publications and presentations, unless consent is provided, as per below.

[Please cross out the phrase that does not apply:]

I	do / do not	approve of being interviewed for approximately 1 hour.
I	do / do not	approve of being audio taped during the interview.
I	do / do not	approve of co-investigator (Dane) attending and observing a timetabled class.
I	do / do not	agree to support co-investigator (Dane) to invite students to participate in the research (observation and photography).
I	do / do not	wish to view the interview transcripts.
I	do / do not	approve of being photographed in the classroom as part of this research project.
I	do / do not	approve of the photographs being used in publications and presentations associated with this research project.
I	do / do not	wish to be notified of publications associated with this research.

Participant's Name____

Email address:____

Participant's signature____

Date ____

Please forward to: Jo Dane, Monash University, Faculty of Art & Design, P.O. Box 197 Caulfield East, VIC. 3145 or use the reply paid envelope provided.

Monash University SCERH Project No. 2006/922

MONASH University
Art & Design

CONSENT FORM FOR STUDENTS

This is a Consent Form for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

I have had the project explained and have read the Explanatory Statement.
This project is voluntary. I understand I can withdraw at any time without consequence.
I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any research publications and presentations, unless by consent as per below.

[Please cross out the phrase that does not apply:]

I	do / do not	approve of being photographed in the classroom as part of this research project.
I	do / do not	approve of the photographs being used in publications and presentations associated with this research project.
I	do / do not	wish to be notified of publications associated with this research.

Participant's Name:____

Participant's Email address:__________________________________
(for notification of research publications only)

Participant's signature:____________________________________

Date: ____

If you have agreed to participate please fold form and place in box provided.

Monash University SCERH Project No. 2006/922

MONASH University
Art & Design

CONSENT FORM FOR FACILITY MANAGERS, ARCHITECTS/DESIGNERS & OTHER STAKEHOLDERS

This is a Consent Form for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

I have had the project explained and have read the Explanatory Statement.
This project is voluntary. As a participant of this interview, I understand I can withdraw at any time without consequence and any contributions made will not be used in the research project.
I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any way in any research publications and presentations.

[Please cross out the phrase that does not apply:]

I	do / do not	approve of being interviewed for approximately 1 hour.
I	do / do not	approve of being audio taped during the interview.
I	do / do not	wish to view the interview transcripts.

Participant's Name____

Email address:____

Participant's signature____

Date ____

Please forward to: Jo Dane, Monash University, Faculty of Art & Design, P.O. Box 197 Caulfield East, VIC. 3145 or use the reply paid envelope provided.

Monash University SCERH Project No. 2006/922

Appendix B: Victoria University Ethics Approval and Explanations

MEMO

TO	Dr Alex Stojcevski School of Electrical Engineering Footscray Park Campus	DATE	5/2/2008
FROM	Professor Michael Polonsky Chair Victoria University Human Research Ethics Committee		
SUBJECT	Ethics Application – HRETH 07/248		

Dear Dr Stojcevski,

Thank you for submitting this application for ethical approval of the project:

HRETH 07/248 New Generation Learning Environments for Higher Education (HREC 07/182)

The proposed research project has been accepted by the Chair, Victoria University Human Research Ethics Committee. Approval has been granted from 5 February 2008 to 31 January 2009.

Please note that the Human Research Ethics Committee must be informed of the following: any changes to the approved research protocol, project timelines, any serious or unexpected adverse effects on participants, and unforeseen events that may effect continued ethical acceptability of the project. In these unlikely events, researchers must immediately cease all data collection until the Committee has approved the changes.

Continued approval of this research project by the Victoria University Human Research Ethics Committee (VUHREC) is conditional upon the provision of a report within 12 months of the above approval date (by **5 February 2009**) or upon the completion of the project (if earlier). A report proforma may be downloaded from the VUHREC web site at: http://research.vu.edu.au/hrec.php

If you have any queries, please do not hesitate to contact me on 9919 4625.

On behalf of the Committee, I wish you all the best for the conduct of the project

Prof. Michael Polonsky
Chair
Victoria University Human Research Ethics Committee

MONASH University
Art & Design

EXPLANATORY STATEMENT TO ACADEMICS

This is an Explanatory Statement for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

The purpose of this research is to discuss with academics how the Engineering Project Studios (EPS), at Victoria University's Footscray Park Campus, support the teaching and learning experience. Academics will currently teach in the EPS. The methodology for this research project has been approved by Victoria University, including the recruitment of academics by nominating those who work in the EPS. The outcomes of this research will contribute to an increased understanding of how particular university facilities affect the teaching and learning experience of the primary university stakeholders.

As an academic, you are invited to volunteer one hour of your time to participate in an interview with co-investigator Dane, to discuss your experience of the Engineering Project Studios.

If you are willing to participate in the interview please complete the attached Consent Form (including contact details) and you will be contacted to arrange a time and meeting place for the interview, within the next two weeks. Approximately 4 interviews will be conducted for the Engineering Project Studios.

The interview will be scheduled to take place at Victoria University, and is intended to be relaxed and informal. The Co-Investigator will ask a series of questions relating to your experiences in assisting student learning within the EPS environment and your observations of students undertaking their learning activities. For transcribing purposes only, the interview will be audio-taped, for use by the Chief and Co-Investigators as named on the Ethics Application. This discussion will take no longer than one hour. No discomfort is intended or anticipated.

You may withdraw from the research project at any stage without consequence and any contributions will not be used in the research.
At no time will you be identified in the research.

The results of the study will be reported in the Co-Investigator's thesis, and may also form the basis of published papers and conference presentations. Such documents will be made available on the Co-Investigator's intranet site at the time of publication; the intranet address will be provided to all participants.

Records will be stored by the Co-Investigator for five years after publication, in a locked environment, after which time the records will be destroyed. Names and contact details of participants will not be released to any person. The Co-Investigator will treat the data responsibly and use all due care and diligence to protect the privacy of all participants.

For further information regarding this research project, please contact:

Co-Investigator
Jo Dane Tel. 03 9903 2751 or by email:
Jo.dane@artdes.monash.edu.au

Chief Investigator
Dr. Bronwyn Stocks Tel. 03 9903 1925 or by email:
Bronwyn.stocks@artdes.monash.edu.au

If you have any queries or complaints about the way you have been treated, you may contact the Secretary, Victoria University Human Research Ethics Committee, Victoria University, PO Box 14428, Melbourne, VIC, 8001 phone (03) 9919 4710. Ethics Project Reference: HRETH 07/248.

VICTORIA UNIVERSITY | A NEW SCHOOL OF THOUGHT

MONASH University
Art & Design

EXPLANATORY STATEMENT TO STUDENTS

This is an Explanatory Statement for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

The purpose of this research is to observe and discuss with academics how the Engineering Project Studios (EPS) at Victoria University's Footscray Park Campus, support the teaching and learning experience. Academics will currently teach in the EPS. Students will be currently enrolled undergraduates who use the EPS. The methodology for this research project has been approved by Victoria University, including the recruitment of academics by nominating those who work in the EPS. The outcomes of this research will contribute to an increased understanding of how particular university facilities affect the teaching and learning experience of the primary university stakeholders.

The research investigators wish to observe students and teachers utilising the classroom environment and to photograph the learning setting, as a form of documenting the activities being observed. Students are invited to provide consent to being photographed.

The research investigators will be seeking to publish the research and request your permission to use the photographs in related publications and presentations.

Participants may withdraw from participating at any stage without consequence and any contributions made will not be used in the research project.
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Participants will not be identified in the research unless consent has been provided to do so.

The results of the study will be reported in the Co-Investigator's thesis, and may also form the basis of published papers and conference presentations. Such documents will be made available on the Co-Investigator's intranet site at the time of publication; the intranet address will be provided to all participants.

Records will be stored by the Co-Investigator for five years after publication, in a locked environment, after which time the records will be destroyed. Names and contact details of participants will not be released to any person. The Co-Investigator will treat the data responsibly and use all due care and diligence to protect the privacy of all participants.

For further information regarding this research project, please contact:

Co-Investigator
Jo Dane Tel. 03 9903 2751 or by email:
Jo.dane@artdes.monash.edu.au

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MONASH University
Art & Design

EXPLANATORY STATEMENT TO FACILITY MANAGERS & ARCHITECTS/DESIGNERS

This is an Explanatory Statement for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

The purpose of this component of research is to discuss the process involved in the design of the Engineering Project Studios (EPS) at Victoria University with key personnel, including facility managers and architects/designers. The outcomes of this research will contribute to an increased understanding of how particular university facilities affect the teaching and learning experience of the primary university stakeholders. The methodology for this research project has been approved by Victoria University, including interviews with academics, facility managers and key architectural personnel.

Dr. Alex Stojcevski has identified you as a key person in the design and implementation of the Engineering Project Studio. Therefore you are invited to participate in an interview with co-investigator Dane, to discuss the process you experienced throughout the design and implementation of the Engineering Project Studio.

If you are willing to participate please complete the attached Consent Form (including contact details) and you will be contacted to establish an interview time and place.

The interview will be scheduled to take place at a venue convenient to you and is intended to be relaxed and informal. The Co-Investigator will ask a series of semi-structured questions relating to considerations of how the EPS was designed. For transcribing purposes only, the interview will be audio-taped, for use by the Chief and Co-Investigators as named on the Ethics Application. The interview will take no longer than one hour.

No discomfort is intended or anticipated.
Participants may withdraw from the research at any stage without consequence and any contributions made will not be used in the research project.

The results of the study will be reported in the Co-Investigator's thesis, and may also form the basis of published papers and conference presentations. Such documents will be made available on the Co-Investigator's intranet site at the time of publication; the intranet address will be provided to all participants. At no time will any participants be identified in the research.

Records will be stored by the Co-Investigator for five years after publication, in a locked environment, after which time the records will be destroyed. Names and contact details of participants will not be released to any person. The Co-Investigator will treat the data responsibly and use all due care and diligence to protect the privacy of all participants.

For further information regarding this research project, please contact:

Co-Investigator
Jo Dane Tel. 03 9903 2751 or by email:
Jo.dane@artdes.monash.edu.au

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CONSENT FORM FOR ACADEMIC STAFF

This is a Consent Form for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

I have had the project explained and have read the Explanatory Statement.
This project is voluntary. As a participant of this interview, I understand I can withdraw at any time without consequence and any contributions made will not be used in the research project.
I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any research publications and presentations, unless consent is provided, as per below.

[Please cross out the phrase that does not apply:]

I	do / do not	approve of being interviewed for approximately 1 hour.
I	do / do not	approve of being audio taped during the interview.
I	do / do not	approve of co-investigator (Dane) attending and observing a timetabled class.
I	do / do not	agree to support co-investigator (Dane) to invite students to participate in the research (observation and photography).
I	do / do not	wish to view the interview transcripts.
I	do / do not	approve of being photographed in the classroom as part of this research project.
I	do / do not	approve of the photographs being used in publications and presentations associated with this research project.
I	do / do not	wish to be notified of publications associated with this research.

Participant's Name____

Email address:____

Participant's signature____

Date ____

Please forward to: Jo Dane, Monash University, Faculty of Art & Design, P.O. Box 197 Caulfield East, VIC. 3145
or use the reply paid envelope provided.

Victoria University Ethics Project No. HRETH 07/248
Monash University SCERH Project No. 2006/922

MONASH University
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VICTORIA UNIVERSITY
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CONSENT FORM FOR STUDENTS

This is a Consent Form for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

“New Generation Learning Environments for Higher Education”

I have had the project explained and have read the Explanatory Statement.
This project is voluntary. I understand I can withdraw at any time without consequence.
I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any research publications and presentations, unless by consent as per below.

[Please cross out the phrase that does not apply:]

I	do / do not	approve of being photographed in the classroom as part of this research project.
I	do / do not	approve of the photographs being used in publications and presentations associated with this research project.
I	do / do not	wish to be notified of publications associated with this research.

Participant’s Name:____

Participant’s Email address:__________________________________
(for notification of research publications only)

Participant’s signature:_____________________________________

Date: ____

Victoria University Ethics Project No. HRETH 07/248
Monash University SCERH Project No. 2006/922

CONSENT FORM FOR FACILITY MANAGERS, ARCHITECTS/DESIGNERS & OTHER STAKEHOLDERS

This is a Consent Form for a PhD research project being undertaken by Jo Dane from the Faculty of Art & Design at Monash University titled:

"New Generation Learning Environments for Higher Education"

I have had the project explained and have read the Explanatory Statement.
This project is voluntary. As a participant of this interview, I understand I can withdraw at any time without consequence and any contributions made will not be used in the research project.
I understand that I am identifiable to the research investigators as named on the Explanatory Statement, but will not be identified in any way in any research publications and presentations.

[Please cross out the phrase that does not apply:]

I	do / do not	approve of being interviewed for approximately 1 hour.
I	do / do not	approve of being audio taped during the interview.
I	do / do not	wish to view the interview transcripts.

Participant's Name____

Email address:____

Participant's signature____

Date ____

Please forward to: Jo Dane, Monash University, Faculty of Art & Design, P.O. Box 197 Caulfield East, VIC. 3145 or use the reply paid envelope provided.

Victoria University Ethics Project No. HRETH 07/248
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