GET CONNECTED!

Collaborative adventures in networked spaces of learning

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Abstract

The Ernst &Young *University of the Future* White Paper (2012) identified digital technologies as a major force of change in education futures. In *Learning Spaces* (2006, p.1.3),Oblinger argues the need for innovative explorations that bring together space, technology and education philosophies to ensure learner success.

James Cook Universityhas its vision on learning futures, setting up digital classrooms modelled on spaces that promote collaborative learning at its Australian campuses in Cairns and Townsville in North Queensland, and its offshore campus in Singapore. The aim is to create learning spaces that are responsive to a digital and networked world, and that engage university students in meaningfully connected ways.

Connectivity of learning is not restricted to students. Networked spaces also open potentialresearch adventures between academics from diverse disciplines. It is as if the very space of the networked classroom draws both students and academicsinto communities of learning.

This paper seeks to explore the notion of 'relational' space itself. It takes up theories from phenomenology, Eastern philosophy, quantum physics,matrixial space, new network science, actor-network theoryand rhizomatics, in order to reflect onhow thesetheories of space offer imaginings towards research adventures involving connective learning (Siemens 2006) in 'networked' classrooms. The site of this adventure is one model 'networked' classroom at the JCU Singapore campus which uses ProVEOS wireless learning technology.

Keywords: phenomenology, Eastern philosophy, quantum physics, networks, rhizomatics, connectivist learning, wireless learning technology

Learning is equivalent to opening a door to a new way of perceiving and knowing

– George Siemens, 2006

1. Threshold

The first thing I notice as I open the door to the new 'networked'[1] classroom is the space. The room is still and quiet – not yet populated by students. Six tables, like rectangle satellite-isles,jut out from the four walls, each withsix chairs arranged three either side. Where each table butts against the wallhangs a large LCD screen,its keyboard resting underneath on the table's surface. Towards the middle of the roomis asmall round tablesupporting aflat-screened computer. This is the central console. However, despite being in the centre of the room, it is not the centre of attention. I'm distracted by an acridsmell– plastics and acrylic - theodour of new paint, furniture, technologyand air conditioning. Ashiver;from tropical humidity, I've stepped into 23 degrees Celsius.But thelightsoon draws my attention back to the visual space. The room is lit from a bank of windows at table level along one wall,softly filtered by blinds. Yet of more interestis how the whole space feels light.

This sense of lightness could be dueto the monochromatic grey-scale. Apart from twomango-yellow doors, one of which I close behind me as I step past the threshold, the room is plain off-white:from the ceiling with its acoustic tiles, to the painted walls.Large whiteboards create a glossy strip along two walls ateither side of the room. The tables that form satellite-isles are matt-white with thin legs trimmed inaluminium. The neatly arrangedchairs are deep slate grey, their insect-like legs end in rollers – suggesting mobility. On the floor isa nondescript industrial-grey carpetpatterned with dull coloured rectangles. The blinds that hang over thewindows are also minimalist. Theirfine-net weave inpale greysoftens the crowning leaves of a slender clumping palm and obscures the view of the sister building on the other side of asmall grassed-square.A wasp takes flight. It hovers over the tall hedge that marks the border of the campus grounds, then zigzags across the wide road to the median strip planted with raintrees; theiroutspread branches host epiphytes –orchids and bird nest ferns –and a trail of ants.Through the raintrees are glimpses of the rooves of two and three story houses, many retaining a semblance of shopfront terraces– despite their modern design and the residential setting.

Beyond the houses is a reservewhereaerial roots and multiple trunks of banyan trees, stands of bamboo, and flowering ginger, offer the semblance of a jungle before being tamed by lawns, lakes and walking paths. The sun illuminates the scene, but cumulus nimbus clouds are forming; white giving way to grey. Thismomentary glance out the window is interrupted as my eyes are drawn back to the interior space by the six large LCD screens mounted at the end of each table, blank white with black borders; beckoning.

The space of the new 'networked' classroom has immediate phenomenological affect. Before engaging with screens and computers or going online, before the anylearningandteaching,the simple spatial arrangement of furniture and technologyhas already invited a sense of adventure. How different this room is to the common imaginary of a classroom, including the one next door. The classroom next door is the same monochromatic colour, it has the same smell and its air conditioning is likewise set too low. The windows give onto the same view, through duplicateblinds. Yet the room feels completely different. It has strict rows of tables. The tables are designed with a front skirting board necessitating that thechairs, roller-less and immobile,must be tucked behind. The chairs allfacetoward one wall of the roomwhere awhite board, large projection screen, standard desk and computer console dominate the space. The arrangement and design of the furniture has caused one wall to become the 'front' of the room; it has created a particular geometry and geography of space – one rendering panoptic power relations that flowfrom a small point at the 'front' to take in a wide arc to the back of the room: from teacher to students; from teaching to learning (Foucault, 1991).It feels like a 'classroom': static, rigid, dominated by instruction – but also primed for subversion.

From this initialexperience of the difference between these classrooms, this paper sets out to explore 'networked' spaces,technologies and learning. James Cook University's offshore campus, JCU Singapore, currently has two model 'networked' classrooms utilising different wireless learning technology systems: *Apple* and *ProVEOS*.

The room described throughout this paper uses the ProVEOStechnology,an AV collaborative system developed by the Singaporean company WOW Vision (*cf.* Teoh et al., 2013). This 'networked' spaceinspired this theoretical exploration as a background to a multi-disciplinary research adventure.[2]

The paper is influenced by theories of relationality whichvariously demonstrate that humans are intimatelyconnected with the world around them – never separate.

Before setting off,a detour to another space of learning – one that likewise led to adventure – will help give a sense of how space affects humans and the imagination:

> He emerged into the strangest-looking classroom he had ever seen. In fact, it didn't look like a classroom at all, more like a cross between someone's attic and an old-fashioned tea shop. At least twenty small, circular tables were crammed inside it, all surrounded by chintz armchairs and fat little poufs. Everything was lit with a dim, crimson light; the curtains at the windows were all closed, and the many lamps were draped with red scarves. It was stiflingly warm, and the fire that was burning under the crowded mantelpiece was giving off a heavy, sickly sort of perfume as it heated a large copper kettle. The shelves running around the circular walls were crammed with dusty-looking feathers, stubs of candles, many packs of tattered playing cards, countless silvery crystal balls, and a huge array of teacups. (Rowling quoted by Graetz in Oblinger, 2006, p. 6.1)

2. Space

We can palpably sense the enchanting space of Harry Potter's Divination classroom. Likewise, academics and students can sense the differentenergyof the 'networked' classroom. The very space resonates with potential. Phenomenology, Eastern philosophies and quantum physics all articulate this complex and finely nuanced notion of resonating space. Rather thanbeing empty and neutral,space is a matrix of intimately woven networks. Space is in relation with material artefactseven as *materia* simultaneously create senses of space. Space is in relation with us, and we with it.

2.1 Phenomenology

In *The Poetics of Space*the phenomenologist Gaston Bachelard undertook a nuanced reading of the lived experience of space through the rooms and furnishings of a house. Bachelard'severyday environment led him to explore the 'poetic' space of a European house, complete with garret and cellar(1969 [1958]).In a very different house, set in the tropics of South-East Asia, aphenomenological-ethnographic analysis of 'material poetics' was carried out through fieldwork in a traditional Malay house. Here, brightly painted carved shutters opened to a garden jungle (Lundberg, 2008).
Similar to these analyses ofspecific houses, our lived experiences of/in classrooms likewise elicitpoetics of space. The etymology of the word 'poetic', and the way in which theorists use the term, is associated with the Greek *poiēsis* meaning 'creation', which comes from*poiein*, 'to make'.Bachelard'sphenomenology allows us to sense the embodied, affective qualities of space and its creative potential for the imagination. As he notes: 'At the level of the poetic image, the duality of subject and object is iridescent, shimmering, unceasingly active in its inversions' (1969, p. xix; Lundberg, 2008, p. 4).

Another phenomenologist, Maurice Merleau-Ponty, wrote of the notion of the chiasm – the intricate intertwining of things and senses. His work articulates a fine weave between the body and perception. We experience the world, he writes,through being part of it (1962, p. xix). 'My body is inescapably linked with phenomena.' Experience 'is lived by me from a certain point of view…I am involved' (1962, pp. 303-304). Merleau-Ponty's legacy helps us to rethink the workings of ourlived environment and the human encounter with and in it. He creates a vision of the world as animate, and of humans being called forth through their environment (1968, p. 147; Lundberg, 2008, pp.1-4).

Martin Heidegger, in his late phenomenology, addressed dwelling and creative thinking. Heidegger's *Poetry, Language, Thought* (1971) demonstrated that it is our ability to dwell in and with the world that enables us to simultaneously dwell upon it. We experience the world by using the things of the world. Even as we inhabit our environment, our environment inhabits us(Lundberg, 2008, p. 6).

Significant to spaces of learning, phenomenology suggests that knowing is not a distanced mental calculation creating a dualism of 'I' and 'knowledge', the human as subject and knowledge as object. Understanding necessarily arises through everyday activities – withspace, furniture, technology, virtuality,students and academics. Knowing is inherently connected and collaborative;finely networked.

2.2 Eastern philosophies

Phenomenology resonates with Eastern philosophies. Heidegger's phenomenology wasitself influencedby Buddhist and Taoist thought(May, 1996).In turn, it is through Eastern practices of meditative concentration– Buddhist, Tantric, Taoist, Sufic, which stress dwelling in the space-time of the here and now –that we come to experience the relationality of the world. This experienceenables us to realise thathumans have never been an autonomous identity separate from the world (Loy, 1988; Loy, 1992, p. 159; Lundberg,2005, pp. 41-42).

Space, in Buddhist philosophy, can be understood through the myth of Indra's Jewelled Net which is a metaphor developed in the school of Mahayana Buddhism to illustrate the concepts of 'resonating' emptiness, interpenetration and dependent origination. The jewelled web describes the interconnectedness of the universe. At each juncture of thegreat netis a multifaceted jewel; each jewel is reflected in all the others(*cf.*Zukav,2009 [1979], pp. 264-268).Every jewel represents a life form, cell, 'atom', orconsciousness. The reflective net shows the world as intrinsically and intimately in relation – a cosmic matrix. Importantly, the metaphor of the jewelled web aims to demonstrate that we are delusional to believe each jewel as a separate entity –a thing or a point in empty space.Meditation is practiced in order to let go of this thingness, to enter the 'void', which is theresonating space of potential.

Buddhist and Taoist philosophies, along with Jungian depth psychology, view this void as therapeutic. In order to be free of a self that imagines it isseparate and outside of relations, we must enter the resonating void. To encounter this space, Buddhism teaches abandonment of the senses. Similarly, the writings attributed to Lao-tzustate that one must become less, rather than desiring to be more.

This is the space of no-thingness. The solution to our fear of the void is to enter into a relationship with nothing, to experience nothing, to become nothing (Loy, 1992, pp. 141–3). It requires breaking through thingness to experience the world and self as in constant interrelation.Space *is* relational (Lundberg, 2005, p. 41).

Spaces of learning are not empty spaces filled with stuff and stuffed with knowledge. Neither are they simply arrangements of tables and chairs, technology and software. Such spaces are also more than wireless networks. They are resonating spaces of potential.

2.3 Quanta and cosmos

Eastern philosophiesgive a sense of the world as intricately in relation. They demonstrate that space is not empty;it forms a net of interconnections from the minutiae of quantatothe infinite vastness of the cosmos.

This was the starting point of Fritjof Capra's classic *The Tao of Physics* (orig. 1975).The young physicist and systems theorist's personalexperience of radical loss of self andincorporation into the interconnectedness of the universe – a phenomenological experience of relational space –set him on an adventure toresearchBuddhist, Tantric, Hindu and Taoistsenses of resonating space and their parallels with quantum physics.Similarly, Gary Zukav's*The Dancing Wu Li Masters* (orig.1979),which examines the history of quantum physics and relativity theoryacknowledges the relation of quantum logic with eastern philosophy.Bothbookstake the neophyte physics reader on a journeyfromthe Newtonian mechanistic model of the universe, which formed the imaginary for classical physics, to thequantumworldview.

The Newtonian universe was conceived through the space of Euclidean geometry – three-dimensional, empty and unchanging. Newton devisedthe mechanistic and mathematical models which enabled the imagining and calculation of solid things moving in this empty space according to the force of gravity(Capra,2000, p. 55).

Atoms were envisaged as hard elementary particles, those classic‘basic building blocks’out of which all matter formed; while the universe became a cosmic machine governed by laws of motion – space, planets and orbits(Capra, 2000, pp.55-64).

Thisclassic mechanistic worldviewwas philosophically based on Cartesian dualism, the notion ofan ‘I’ as a separate entity from the world,which, in turn, enabled thebelief in an objective observer who could stand outsideof the field of observation. This philosophy, combined with Euclidean geometry, creates a dualistic imaginary of full-matter moving in anempty-void – from atoms to outer space (Capra, 2000, pp. 55-64).

Newtonian physics was first challenged in the C19ththrough work on electric and magnetic phenomenon. In what became known as electrodynamics, space wasno longer conceived as simply empty,itconsisted of fields of energy(Capra, 2000, 59-61). Despite these new theories, the mechanistic worldview held strong.Then, at the turn of the C20th,the emerging new areas of atomic physics and relativity theory challenged classical physics and its concomitant notions of matter and space. In 1900 Max Planck wrote a paper that discussed ‘energy packets’ and ‘quantized oscillators’ and the term *quantum* entered physics (Zukav, 2009,pp.52-59). At the universal level Einstein’s special theory of relativity, published in 1905, revealed that space is never out of relation – including with time; this leads to the four-dimensional continuum of space-time.[3] Likewise, absolute space and absolute time do not exist; they are relational to the observer. Later, in 1915, Einstein published his general theory of relativity, which demonstrated that gravity has the effect of ‘curving’ space. In the new theories of the cosmos three-dimensional Euclidean geometry could not work; ‘empty space’ loses all meaning (Capra, 2000, p. 62-64).Similarly at the level of the miniscule,atomic physicswas shattering the notion of ‘solid objects’. Atomic physicsfirst demonstrated that atoms were not essential particles but were strangely liketiny cosmoses – similar to Newtonian planets in orbit. Then in the 1920s, this notion was, in turn,rent asunderby the discovery of the subatomic world. Subatomic phenomena consist of both waves*and* particles. Not dualistic either wave/or particle – but potentially each. We have entered the paradoxical world of quantum physics (Capra, 2000, p. 65).

What is radical about quantum physics is that matter does not exist as such. There are only ‘tendencies to exist’ and ‘tendencies to occur’. Quanta are notfixed – they are probability waves. In the words of FritjofCapra:

At the subatomic level, the solid material objects of classical physics dissolve into wave-like patterns of probabilities, and these patterns, ultimately, do not represent probabilities of things, but rather probabilities of interconnections. (2000, p. 68)

Importantly, probability is affected by, and interconnected with, everything else - including scientists and their experiments. In this finely wovenweb of relations Cartesian dualism, which induced the imaginary of a separation between observer and observed, between subject and object, is not sustainable (Capra, 2000, p. 69). We are returned to the cosmic net of Indra with its multifaceted jewels reflecting everything within everything*ad infinitum*. Like a Zen koan, the paradox of quantum phenomena induces radical shock. As the radical quantum physicist,Niels Bohr, remarked: “Those who are not shocked when they first come across quantum theory cannot possibly have understood it” (quoted in Zukav,2009 [1997], p. 289). This shock is an interstice – an opening. Potential adventure.

Quantum physics thus challenges conventional westernthinking and suggests parallels with ancient Eastern philosophies, most famously expressed throughBohm’s collaborative thinking adventure with JidduKrishnamurti(www.bohmkrishnamurti.com/).Nevertheless, the dualistic concept of empty space and solid thingsis pervasively ingrained in our academic discourses. It remains extremely difficult to think beyond this imaginary – or to find the words to describe quantum and other nondualistic notions of the world.

Quantum physics and Eastern philosophies shake our very foundations – there are no foundations.Quanta are in wave and particle relations all the time, so all the hard stuff we take as real around us – classrooms, desks, seats, LCD screens, computers, technologies, software,blinds, palm trees, roads,a wasp, raintrees supporting epiphytes and ants, banyan trees, bamboo, ginger flowers, or clouds forming in the distance - are energy relations.Quantum physics reveals the world as networked through and through.

Thus, to introduce the ‘networked’ classroomtogether with a quotedescribing Harry Potter’s Divination classroom is not merelyfanciful. This juxtaposition brings the two spaces of learning into relation – setting up a vibration.

The invocation of magic thatthe Harry Potter quote suggestsholds real potential. Such nondualistic ways of understanding our relations with the worldhave the possibility toopen up notions of learning andteaching– and of understanding the spaces in which thinking is practiced in the everyday life ofhigher education.

2.4 Matrixial space

The above senses of space evidenced through phenomenology, Eastern philosophies and quantum physics areallmatrixial. Etymologically this term connotes both theheld qualities of the womb,andthe experimental qualities of a petri dish with its liquid or agar medium.In turn, the petri dish of science invokes the proto-experiments of alchemy, which magically conjure a connection back to *Harry Potter*. A matrix is a substance or situation that disappears into the background while allowing something else to emerge (Lundberg *et al*., 2012, p.12; Lundberg, 2013, p. 3). It is, in this regard,amedium of potential. The matrix is also a finely woven network.

The movie *The Matrix* demonstrates these senses of matrixial space as an emergent medium that is thoroughly networked. It does this through creating adystopian scenariothat is pervasively panoptic.The film is strongly influenced by William Gibson’s*Neuromancer*,theclassic cyberpunk novelin which the term cyberspace was coined and the notion of the matrix first described:“The Matrix: a world within a world, a graphic representation of the databanks of every computer in the human system; a consensual hallucination experienced daily by billions of legitimate users” (1995 [1984], backcover).In the movie,humans are held within womb-pods and ‘jacked in’ to the matrix, which is both the network of a power gridand a dream matrix. Peopledo not know that their reality is virtual(Wachowski*et al*., 1999).Reality and virtuality are not simply either/or dualism, for each ‘space’ symbiotically requires the otherfor the film to work. Delving into this virtual reality is, as alluded to in the film,like fallingdown the rabbit hole of *Alice’s Adventures in Wonderland*(1865).

Akin to the spinning yin yang symbol combined with fractal geometry, the symbioticrelation of virtual and real in *The Matrix*is a complexrecurring pattern, repeated in a pattern, within a pattern(Lundberg, 2013, pp. 2-3;Mandelbrot, 1983).

The 'real' world is a dream matrix in which we experience theillusion of hard thingsandlinear space where everything can be measured and surveyed. The Euclidean geometry of Neo's work life is portrayed throughthe grid of work cubicles, neon-lit grey and beige, an 'iron cage of bureaucracy'that calls up concomitant accounting systems, including, in the neoliberal world of universities, the managerial workload models and performance measurements academicsfillin to calculate their individual outputs – a form of paper self-surveillancethat extends the reach of the panopticon.

The only escape is to enter further into the matrix, face the matrix, become the matrix. Aradical binary choice: either red pill or blue.Take the red pill and there is no turning back – you enter the matrix.Neo awakens to a dystopia of environmental destruction, desolated cities, diasporiccivilisations, and pirate spaceships – power relations everywhere. However, in the networked world of virtual-reality,particle physics gives way to the quantum world of particles *and* flows, waves of potentiality. The heroNeo must learn to let go of thingness in order to be able to experience this space. Hence the significance of the words spoken by the child protégé in the waiting room of the Oracle,"Do not try to bend the spoon — that's impossible. Instead, only try to realize the truth: there is no spoon"(Wachowski*et al.*, 1999).

The Matrix is good to think with.[4] It suggests that networked classrooms are in no simple way utopian spaces,and they do not do away with power relations. Nevertheless, 'networked' classrooms are spaces of potential. The movie also portrays – through the inversion of child protégé as guru and Neo as neophyte – that teachers and studentshave to learn differently,to let go of 'thingness' in order to experience the collaborative potential of matrixialspaces of learning.

Networked spaces of learning are complex settingsin which old-schoolscenariosencounterfuturisticvisions.

This space creates the potential for new ontologies and epistemologies of learning and teaching while simultaneously being embroiled in traditional teaching and learningpractices. Like *The Matrix*, the networked classroom calls up parallel scenarios revealed as entwinements of both discipline and freedom.

Students start bustling into the room, eyes scanning.They head off in various directions towards the satellite-isles of tables and chairs. Bags are dumped down: on tables, on chairs, under tables, in the spaces between ripe for tripping over. The sound of a beep near the door followed by an electronic female voice: 'thank you'. The students at various tables get out their laptops oriPads;[5]*smart phones always close to hand. A few take out printed material of lecture notes or the tutorial guide for today's class (only to shortly be told that printing is unnecessary, which will lead to anxiety, the hard materiality of printouts makes many students feel secure). Another beep, followed by an electronic: 'please try again'. Again a beep: 'thank you'. Mostly the students are quiet, expectant. Those who arrive in groups with friends actively colonize a particular satellite-isle. Electronic beep in the background. The noise triggers a response in some of the already seated students.They get up and go back towards the door. A chaoticqueue forms around a black box set on the white wall beside the mango-yellow door. Each student presses a finger onto the neon-green square of light indented in the black metal box. Beep 'thank you'. Beep 'please try again'; beep 'please try again'.Human sigh of frustration followed a couple of giggles.Beep 'thank you'. Sigh of relief. The soundscape of biometric attendance, machine entwined with human, becoming cyborg.*

3. Networks

Students enter a new 'networked' classroom. The networks of this space resonate acrossmultiple plateaux.To begin with, there is the plateau of biometric attendance that evokesthe power relations of a bio-*matrix*. In the global education hub of Singapore,which has attracted many international universitiesto enter into twinning programs, joint ventures,orto open offshore branch campuses– it is necessary for satellitecampuses to track the attendance of theirforeign students in order to adhereto Singapore's higher education regulations.

Thus, the biometric surveillance device is used to demonstrate and calculatethe alien campus's compliance with the regulations of the host state.Yet, on another plateau,students (Singaporean, expat, andforeign) simultaneouslyenter a parallel space where furniture is set out in networked arrangements.

Satellite-isle tables spatially instantiatestudents' bodies into clusters that encourage collaborative learning. Mobile chairs potentially allowstudents to glide from one satellite-isle to another –linking ideas, networking, setting space in motion, forming 'lines of flight' (Deleuze and Guattari, 1987 [1980]). Large LCD screens with keyboards and a fragile-looking central console, use wireless learning technology (WLT) to connect students to each other, or teacher, and beyond the room through the world wide web. Thus, in the parallel dimensions of this networked classroom students havethe world at their fingertips: both a biometrics world of surveillance, as well askeyboardsas portals to cyberspace; they formsatellite clustersable to work in teams, and are mobilised to create links to otherteams and shared ideas. However, networked space it not always entered into easily. The no-thing of the void, the paradox of quantum physics, or the virtual-reality of *The Matrix*can be terrifying.Students may prefer to choose the quotidian safety of the blue pill. Learning and teaching practices need to emphasise ways of empowering students and academicsto take up the potential of networked space – to adventure.

3.1 Network science

Theorists of networks are not merely distanced observers writing *about* networks,they are engaged*with* the new technological environment of the C21st. New technologies have ontological and epistemological impact; they affect our very ways of being in the world and ways of knowing the world. In this regard, the world wide web and wireless learning technologies (WLT) have influenced theoretical work in network science.

New network science was firmly established at the beginning of the millennium through synchronousworkpublished byAlbert-LászlóBarabási (2003) in the field of physics, andDuncan Watts (2003) and Steve Strogatz (2003)in mathematics.

Network science elucidates the properties of networks on and across multiple plateaux, including: neural networks, food networks, transport networks, financial networks, telecommunicatons, the world wide web,viral networks (virtual and medical),ecology,and social networks(Buchanan, 2002).

Recently, network science has been taken up in interdisciplinary projects in humanities and social sciences. AtJames Cook University it forms the thematic basis ofa core first year Bachelor of Arts subject, *Our Space: Networks, Narratives and the Making of Place* (Lundberg and Kuttainen, 2011-2013), which appropriately, at the university's offshore campus in Singapore, is tutored in the new'networked' classroom. In turn, concepts from this subject have lead to further interdisciplinary research projects (*cf.*Kuttainen*et al*., 2013; Lundberg *et al*., 2012;Lundberg, 2013).

Crossing between disciplines is not anathema to Network Science. Indeed, the scientists' inspirationfor their theory came froma social psychology experiment devised by Stanley Milgram in the 1960s. To understand how people are linked in webs of connections, the psychologist used the postal network to demonstrate that people could get a letter from one place and person, to an unknown recipient in another location, in approximately six relay postings.This became known as six degrees of separation. In the late 1990s Watts and Strogatzwere profoundly shocked by the idea that over six billion people could be linked through just six connections. The scientists' aim was to model this phenomenon through a mathematical graph(Buchanen, 2002, pp. 14-15; Hilton and Talas, 2009).The graph revealed that the notion of six degrees of separation is a 'small-world' network.Links between people are not spread out evenly; social life clusters.The networks of transportation, internet, economics, biology and ecologylikewise present small-world phenomena. In each network, most nodes are linked to only a few other nodes. But some nodes have lots of links. These hubs shorten the paths between all the nodes in the entire network.An important principle of six degrees is that it is not about strong connections; significantly, weak links make the connective leap from one cluster over to a wholenewcluster in the network.

Furthermore,links from different plateaux can leap one to another. For instance, while our evolutionary and taxonomic science tells us that chickens, viruses and humans are separate categories; bird flu demonstrates that viruses link birds and humans, they cross species. In turn, airlines become carriers of avian flu, airport hubs arepotential nodes in epidemics. Thesame features are likewise at play in cyber viruses.

3.2 Actor-Network Theory

The crossing of plateaux has been a hallmark of Actor-Network Theory (ANT) whichemerged out of the inter-disciplines of science and technology studies, the sociology of science, and anthropology in the 1980s. ANT employs an ethnographic approach to investigate qualitative case studies of sites from laboratories, to fields, to factories.It is noted for mapping the relations between things and ideas through analyses of science and technology developments, famously using a practice in which all 'actors' in a field site, human and nonhuman – animal, plant, microbe, technology, reports, photographs– are treated as active participants (*cf.*Callon, 1986;Latour, 2005). ANT connects what our taxonomic systems imagine as separate.The oxymoronic term actor-network stresses that actors are, in fact,interdependent networks. The methodology of actor-network theory is to follow heterogeneous trails. As Bruno Latour notes with genuine humour, the acronym ANT is "perfectly fit for a blind, myopic, workaholic, trail-sniffing…collective traveller" (2005, p. 9).

In the case of the 'networked' classroom actors involved in creating this space of learning include: the room, furnishings,air conditioning, academics, ProVEOSwireless learning technology, curricula,iPads, biometrics, laptops, cyberspace – and the space outside the window of tropical air,flying wasps, raintrees, orchids,ants, banyan trees, bamboo, flowering gingerand clouds growing ominously grey-black.

Thoughts wander from rain clouds to cloud technology. On the websitefor the company WOW Vision that produces the ProVEOS wireless learning technology used in the model 'networked' classroom, the section entitled 'About Us' states:

Through groundbreaking advancements in the provision of inter-device cloud AV and wireless solutions, the seamless transmission of information builds a firm foundation for higher efficiency, productivity and collaboration…. (http://wow-vision.com/)

Students are busy in teams of six sitting at satellite-isles working on a collaborative project on their LCD screen. They group around instructing each other, dividing tasks and flicking between multiple screens open to the university online platform, a tutorial instruction sheet, the referencing guideline, websites, and the PowerPoint on which they are working. Some heads are bent towards each other - sounds of discussion in Chinese, Indonesian, Malay, Tamil, and English. Some students sit back from their table text messaging.Someone exits the room – either to go to the bathroom or to take a call. Others are doing online searches individually on their iPads, laptops or smart phones – it is difficult to tell if they are still on topic or have wandered to personal communication or fallen down the labyrinth of the world wide web. In this room I find myself nomadically following eddies of energy –activity or non-activity, questions or areas of silence – attention ranging between clustersof students, trying to feel a space between guidance and allowing students to find their way, collaboratively.

A student enters the room. "Sorry late. Slept in – so sleepy lah." Her voice in sing song Singlish. We're about to have an afternoon rainstorm – it's 1.15pm – but chronology makes little sense to students whowrite essays and surf the internetin the dark hours of the pre-dawn light.

She joins her team working on the'PechaKucha'style presentation. This is a tutorial group for the subject 'Our Space:Networks, Narratives and Making of Place' which is thematically based on network theories. Students work in clusters of six (their own six degrees of separation). In turn the PechaKucha PowerPoint consists of 20 slides, each run automatically at 20 seconds – we've calculated the timing: 6.666 minutes. We also know that thePechaKucha format, which was developed in Japan, has gone viral, spreading globally (http://www.pechakucha.org/).

In this 'networked' classroom, the concepts of the subject are able to rise like fractal patterns spiralling outwards -concepts, theories and readings arising through practice, arising through the space of the room, arising through collaborative technology, arising through cyberspace.

Thunder rolls outside the window. Heavydrops of rainstart to fall. Black clouds enclose our space.

3.3 Rhizomatics

Actor-network theory,in turn, resonates with the network philosophyof rhizomaticsdeveloped by the philosopher Gilles Deleuze and psychoanalyst Félix Guattari in theirintroductory chapter to*A Thousand Plateaus* (1987 [1980]). It is an image of thought based on the botanic rhizome. In the tropical setting of James Cook University's Singapore campus, the theory evokes images of ginger, bamboo and sympodial orchids.Rhizomaticsfurther argues that animals and objects may form rhizomes. Ant trails are rhizomes;so are burrows. We are never far from the myopic ant of Actor-Network Theory,or from Neo following the white rabbit of Alice in Wonderland into the finely networked cyberspace of the*The Matrix*.

Rhizomatictheory and research allows for multiple, non-hierarchical entry and exit points in analysis and presentation of artefacts and thought.It necessitates connection and heterogeneity where any node of the rhizome can connect to any other (Deleuze and Guattari, 1987, p.8). The underground root of the ginger is transversal with nodes connecting to other nodes in all directions; ant columns are comprised of a multitude of ant bodies;animal burrows are labyrinths of multiple entry and exit points.

Rhizomaticsargues for multiplicity. There is no originary Oneness to be divided into binary hierarchies. "A multiplicity has neither subject nor object, only determinations, magnitudes, and dimensions…" (Deleuze and Guattari, 1987, p.8).

Rhizomes rupture. Shattered at a particular pointonly to start up again on an old line, or form a new one.If we breakoffa node of ginger and shove it in the ground elsewhere, it forms a new network.

We “can never get rid of ants because they form an animal rhizome that will rebound time and again after most of it has been destroyed” (Deleuze and Guattari, 1987, p. 9). A tunnel of the burrow mayfall in, butanotheris built, adding to the labyrinth.

Rupture may also explodetwo heterogeneous elements into a rhizome.The relation of the wasp and the orchid evokes this image.Many species of orchids display labellum morphology and coloursand give off pheromones of a female wasp species, thus attracting the male wasp, which enablespollination between orchids.
It is not simply that the orchid imitates thewasp. There is “a becoming-wasp of the orchid and a becoming-orchid of the wasp” (Deleuze and Guattari, 1987, p. 10). Mimesisproduces an excess(*cf.*Callois, 1984). The orchid-wasp image ruptures the hierarchical and dualistic philosophy of origin and copy. Wasp and orchid form a ‘symbiotic emergent unit’.

Therhizome saps the pervasive Western botanical-philosophical image of the tree: evolutionary trees, genealogical trees, the tree of knowledge –biblical and educational. The aboreal image of knowledge conjures up notions oforiginal oneness (tap roots); linear growth (trunks);andbifurcating disciplines (branches). While an arborescent model works with linear development, rhizomes indicate horizons and connections. Knowledge in this scenario is like the world wide webwhere links lead to links, to broken links, to be taken up in new links within links.

As Brian Massuminotes, Deleuze and Guattari create an image of “a rhizome network strangling the roots of the infamous tree” (1987, p.ix). However, the theorists are not simply anti-tree; in fact, the banyan tree of the tropics, also known as the strangler fig, is a spectacular example of rhizomatic imagery(Lundberg, 2008, pp. 9-10).

‘Networked’ classrooms have the potential to be rhizomatic;yet, these spaces of learning are simultaneously arborescent. The ProVEOS classroom certainly allows for multiple non-linear collaborations. However, incorporated within its wireless learning technology (WLT) system are also panoptic aspects. As the WOW Vision website states:

Leverage on the VEOS to transform traditional classrooms from a teacher to student centric model to create a highly conducive, exciting and creative environment for learning. Students can effortlessly display their presentations; teachers can maintain classroom discipline with the Classroom Management System (CMS), and encourage creative discussions by utilizing the electronic whiteboard and collaborative QnA features. (http://wow-vision.com/)

Itis evident that the company has embraced new philosophies of learning that call for collaborative adventures that are exciting and creative.
It has also correctly ascertained that educational institutionssimultaneouslya dvocatesurveillance and disciplinary measures.Education is profoundly nested in imaginaries of trees of knowledge, even as it is also opening torhizomatic horizons. 'Networked' classrooms are potential rhizomes – if welearn to think andteach in rhizomatic ways.

4 Connectivity

"What is the pattern that connects the crab to the lobster and the orchid to the primrose, and all four of them to me? And me to you?" (Bateson, 1979, p. 8). This 'koan' on the connectivity of patterns is from Gregory Bateson's ecology of mind project (1972; 1979) inwhich he wove anthropology, early systems theory, and cyberneticsin an interdisciplinary practicethat wasinspired by hisethnographic fieldwork in Bali[6] andreading of Alfred Russel Wallace's*The Malay Archipelago* (1890 [1869]),in which the co-theorist of evolution observes theinterdependence of natural systems.

Bateson's 'ecology of mind' influenced both the philosophy of rhizomaticsand the science and technology studies of Actor-Network Theory.In turn, these theories,along with Network Science, resonate with the new theory of connective learningthat entwines notions of networks and ecologies.

4.1 Connective learning

Learning is never one thing. Applying one theory to all learning scenariosleads to rigid and hierarchical analysis. The theory of constructivism is strongly advocatedincontemporary

Western education to promote thelearning of ideas, concepts, and critical thinking; however, this theory is set up in opposition to rote learning, which becomes denigratedas a system ofConfucian heritage Eastern education (*cf.* Joyce and Lundberg, forthcoming).Rather than falling into dualistic thinking,which creates separatistorientalist/occidentalist imaginings of east and west(*cf.*Robertson and Lundberg, 2013),constructivist and mimetic learning practices are better analysed according to the particular learning scenario.Attention to the particular,also alerts us to the need for theories of learning to change with the emerging technological environment.

In *Knowing Knowledge*(2006) George Siemens proposes a newtheory ofconnective learning for a digital age. "Knowledge has changed from categorization and hierarchies, to networks and ecologies. This changes everything and emphasizes the need to change the spaces and structures of our organizations" (2006, p. v). Siemens explicitly drawson the theory of Network Science: "Knowing and learning are today defined by connections. CONNECTIVISM is the assertion that learning is primarily a network-forming process" (2006, p. 15).

At the threshold of the knowledge economy,therise of cloud technology makes connections, rather than content, the source of value.In the 'Our Technology' section of the WOW Vision website, ProVEOS cloud technology is further elaborated:

> With Cloud IT and AV convergence, users will also be able to share, collaborate and present content to a wider audience, building and maintaining relationships as boundless as the Internet itself. (http://wow-vision.com/)

Knowledge is changing at such a rapid rate that its obsolescence, in some disciplines, is within the lifetime of a students' degree.

As academics we are preparing students for a workplace that as yet does not exist. Our aim is to teach the skills of connections to learning and a joy in continued learning.In short, the era of the network 'cloud' invites a different grammar; one that moves from the thingness of 'knowledge' (noun), to the*poiēsis*of 'knowing'.

Throughout*Knowing Knowledge*, the theory of connectivist learning is presented through metaphors, imagery and diagrams – and theirrepetitions. Less a linear argument, this techniquesuggestsa horizontalpractice oflinking nodes.[7]The'images' evoked through the notion of connectivist learning, in turn, resonate with theories elucidatedthroughout this paper.Readers are invited to make their own links, I have chosen just a few for elaboration.

The explicit network connection mapped between the internet cloud, wireless learning technologies (WLTs), and students, calls up Actor-Network Theory. In this scenario human and non-human actors are involved in inextricable relations; we can no longer privilege the human as subject and technology as object.

The ecology of learning as an aspect of connective learning is suggestive ofrhizomatics. Drawing on the work of John Seely Brown, Siemens notes the attributes of an ecological system as open ended, dynamic, interdependent, diverse, self-organising, adaptive and fragile. Relating this to collaborative technology, the potential for cross-pollination of ideas is stressed (2003).In turn, this image vividly evokes the symbiotic orchid-wasp rhizome.

As universities enter the age of the knowledge economy, knowledge itself is undergoing a paradigm shift synchronous to the shifts in philosophy and science. "Our conceptual world view of knowledge—static, organized, and defined by experts—is in the process of being replaced by a more dynamic and multi-faceted view" (Siemons, 2006, p. 3).These words resonate with the notion of the jewelled net of Indra; an image that in turn helps us to sense the intricatenet ofmatrixial space and the quotidian life of virtual reality that cannot be reduced to either/or dualisms.

As knowledge changes from a settled state of hard facts, to a soft state of rapid change, we must learn to engage and interact with knowledge in order to create 'spaces' of lifelong learning.

Or, as Siemen's repeatedly notes, we must learn to dance (2006). We are returned to a poetics of the quantum particle-wave dance and its relation with Eastern philosophy. The image is explicit in the title*The Dancing Wu Li Masters*, while the dance of Shivais drawn upon on in *The Tao of Physics*. In turn, a two metre sculpture of Shiva's cosmic dance graces the massive hall of CERN (European Centre for Research in Particle Physics).

These theories demonstrate that space is not empty, it resonates with potential and calls us forth to adventures.Significant to spaces of learning, phenomenology suggests that knowing arises through the particular – through our everyday encounter and practice with space, including spaces of learning.

5 Exit

The description of a networked classroomat the threshold of this paper reminds us that learning takes place in and with spaces – physical, virtual and imaginative. The space of classrooms isimpacted by the arrangement of the furnishings, the temperature of the air, and the accessibility and applications of the technology. Students and academics are not separate from this space; never disconnected, they are in relation with and through this environment. They are, in short, 'jacked in' to matrixial space. Physical and virtual aspects of spaces of learning are emotionally affective – invoking wonder and exploration; or conditioning hierarchical power relations of discipline. Students and academics actively sense classrooms – the feel, the look, the sound and smell. They sense with their bodies, just as learning is embodied; nevera dualistic practice that happens in the mind or brain.Students and academic engage with their surrounds; recognise patterns of space and patterns of learning.

The air is thick and humid, filled with sounds and currents of movement – a cacophony and chaos of energy that creates fractal swirls.Students are packing up computers and iPads. Excited chatter in various languages.Electronic beep 'thank you'. The rat-a-tatpelt of tropical rainas the door of the classroom opens.

Squeals of excited laughter.Ringtones of smart phones; a barrage of text messages received and sent.Groups of students mill around chatting and asking questionsabout their team project.Beep 'please try again'; beep 'please try again'.Giggles.Beep 'thank you'. Shy students stand in the background, their stillness drawing my attention as my body moves towards these quieter eddies.

Still consulting students, we move towards the threshold becoming enveloped in damp rhythmsof the pouring rain. Sunny farewells as I close the mango-yellow door behind me.Shortly the same door will open again for a different subject– and to a new adventure in learning and knowing.

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End Notes

[1]JCU Singapore management use the term 'model classroom' or, referring to the technology utilised, the 'ProVEOS room'. My term 'networked' articulates the way in which the space functions at the interstice between students, academics, space, technology, wireless learning, and curricula.

[2]The interdisciplinary research team includes: AbhishekBhati (Business), Margaret Carter (Education);TeohTeik Toe (IT) and Anita Lundberg (Liberal Arts and Anthropology).

[3]Space-time is now considered to be 10 dimensions – normally 9 of space and 1 of time – although some physicists estimate different numbers of time to space adding up to 10 (*cf.*Hawking, 1988;Kaku, 2008; Ferguson, 2011).

[4]This is an allusion to Claude Levi-Strauss's 'natural species are chosen not because they are "good to eat" but because they are "good to think"' from *Totemism* (1963) in which he demonstrates the 'matrix' of structuralism – the idea that there are underlying networks that we may not 'know', but can learn to see the patterns of how they are related to each other. The notion of structuralism with its allusion to a knowable structure, is, of course, radicalized in post-structuralism.

[5]Full-time students at JCU Singapore are given an *iPad* as part of their contract. This does not apply to exchange students.

[6]The aim of rituals in Bali is to maintain the balance of Balinese cosmology, a pattern that is repeated from macro to micro. (Bahasa Indonesia discussion with Pak Putra Ubud, Bali, 4 October, 2013).

[7]The numeric and decimal system imposed upon this paper is a demonstration of the continued hierarchical structure inherent in academic practice; numberingas branches of the arboreal system.