New metaphors for understanding epistemic practices in higher education online settings

Lyn Campbell
The University of Melbourne
infolyte@bigpond.net.au

Ted Clark
The University of Melbourne
ejtc@unimelb.edu.au

Introduction

Online learning practices in higher education settings are most commonly discussed from the theoretical position of social-constructivism (Berge, 1995; Harasim, 2000; D. Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; D. W. Johnson & Johnson, 1996; von Glaserfeld, 1996). Within this theoretical framework, discussions of pedagogy and curriculum focus on knowledge practices, which emerge from the interactions between students and their teachers (Laurillard, 2002; Postle, 2003; Salmon, 2002). Scant attention is paid to the role of technologies, diverse materials and other bodies, which may be drawn upon to support the online teaching and learning activities. In these constructivist accounts, teaching practices emerge from teachers and their curriculum and pedagogic designs, while learning is something that emerges from social interaction.

This paper considers the use of blogs and webpage subscription feed aggregators and other social software applications that were used in a recent online education subject offered in a higher education setting. The teaching and learning activities that are traceable in this subject (and some of those that are only hinted at) are analysed with a view to describing emerging epistemic practices involving ecologies of humans and non-humans that reside in digital networks. In the course of the discussion, the paper seeks to open up alternative ways to understand the learning practices that occur in these environments and to identify how two theories, connectivism (Siemens, 2005a, 2005b) and actor-network theory (Latour, 2005; Law, 2009) may be usefully ‘applied’ to the study of learning in networked spaces.


Connectivism has a specific focus on learning and directs it gaze most sharply at the interactions among teachers, students and learning technologies in networked spaces (Downes, 2006; Siemens & Tittenberger, 2009). Connectivism is concerned to identify how digital networks and social networking software contribute to student learning.

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1 Commonly, and hereafter referred to as RSS feeds.
The paper presents a data story,\textsuperscript{2} a series of moments captured in one university’s networked learning spaces. Subsequently, two accounts are made of how these ‘moments’ might be understood. The first account is informed by concepts from connectivism, and the second by concepts from actor-network theory.\textsuperscript{3} Each account seeks to provide an understanding of the nature of networked learning and perhaps offers ‘new’ metaphors for understanding learning mediated by ICTs.

Both accounts attempt to show the strength of thinking \textit{materially} and researching with a focus on \textit{practices} and their material enactments. It is argued, by both authors, that thinking and researching in these ways has potential to uncover the complexities, uncertainties and specificities of online learning practices.

\section*{Theoretical accounts of networked learning}

Practitioner literature, from online educators, represents the bulk of the literature on networked learning and operates from a social constructivist position, asserting that teaching and learning are social practices and that knowledge is socially constructed. Learning is thought of as an active, goal-oriented and self-regulating process of knowledge construction (Harasim, 2000; Salmon, 2000). The learning theories of Piaget (1950), Bruner (1986) and Vygotsky (1978) are drawn upon to provide theoretical grounding for claims that cognitive growth is promoted in collaborative networked environments (Anderson & Garrison, 1998; Collis, 1994; Garrison & Anderson, 2003; Sherry, Tavalin, & Billig, 1999).

From this position, the teacher’s promotion of learning communities is seen as central to the success of online education. Through the development of dialogue between students and teachers, deeper engagement with course content and reading material is fostered (Harasim, 1995; Laurillard, 2002; Salmon, 2002). In these accounts, dialogue and learning communities are conceived of as ‘resources’ that make for more effective learning.

Predominantly humanist in their orientation, social constructivist accounts have paid little attention to the tools of learning as having any substantive role in building knowledge practices. The software and hardware of networked learning are reduced to the role of ‘aids to learning’ (Waltz, 2004), and are rarely referred to in the literature unless they interfere with the learning process (Berge, 1998).

Connectivism and material semiotics adopt a different orientation when discussing online learning activities. Taking a more symmetrical approach, they consider learning in networked environments as emerging through the interactions between ‘networks’ of humans and non-humans, as \textit{socio-material} affairs.

\section*{Connectivism – social constructivism meets web 2.0 technologies}

\textsuperscript{2} The data story is taken from a body of data collected by one of the authors and a teaching colleague, with ethics clearance from their university, and signed consent from their students as part of an effort at reflective practice. Both teachers were interested in gaining a better understanding of students’ experiences in networked spaces and how they, as teachers, might improve these.

\textsuperscript{3} There is no attempt to compare and contrast these two framings (that may form part of a thesis under development by the two authors), as they emerge from very different ontological positions, making comparison difficult and perhaps somewhat pointless.
George Siemens (2005a) has proposed networked online learning connections, practices and communications as possible indicators of learning. He puts forward a learning theory called “connectivism”. Working from a connectivist position, Downes (2006) asserts that learning and knowledge making in networked learning are distributed practices and are not located, or exclusively located, in a single place or person:

… this thinking is centred around the theory of connectivism, which asserts that knowledge - and therefore the learning of knowledge - is distributive, that is, not located in any given place (and therefore not 'transferred' or 'transacted' per se) but rather consists of the network of connections formed from experience and interactions with a knowing community (Downes, 2006, p.1).

Learning theories derived from behaviourism, cognitivism and even constructivism have been able to account for and encompass technological interventions to varying degrees without displacing the perception that learning and knowledge reside largely inside the mind or body of the learner.

Learning in connectivism is seen as enabled or residing across many elements in a connected network. It not only evolves inside the individual learner as argued by (cognitive) constructivists, but also within a community of practitioners as argued by Wenger (1998). Connectivism acknowledges experience and interactions with a knowing community, and positions learning as located in the connections that form across the network members, both human and non-human (Siemens & Tittenberger, 2009).

Connectivism posits that the transfers or flows of learning and knowledge are made possible by online digital networks. Networked technologies and connections replace the single site of learning (albeit human minds, bodies or a practice) to offer a more symmetrical interplay of actions and connections between humans and non-humans.

Stephen Downes clarifies the position:

…connectivism is the thesis that knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks” (Downes, 2007, p.1).

Learning may exist and be accessed by connecting a person, a community or technology using various agents, software tools or online mechanisms. Metaphors for learning here might include socio-technical connections as a way of understanding networked learning.

What is a connection? What is a network?

Siemens (2005a) defines connection as: “…any type of link between nodes”. He goes on to explain that the aggregation of nodes results in a network and that once a network forms or is aggregated, the flow of information can move from one node to another with relative ease.

Nodes can be people or non human entities or even more generally other networks: “… the nodes can be individuals, groups, systems, fields, ideas or communities; nodes can be networks themselves” (Siemens, 2006). So within an online learning network, a node can be a person or some other material element like a webpage or a
software application or organisation or also ideas. The important element for learning is not the node however, but the connection. For Siemens:

Learning (defined as actionable knowledge) can reside outside of ourselves (within an organization or a database), is focused on connecting specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing (Siemens, 2005a).

Connectivism insists that learning relies upon a dynamic body of knowledge, which changes over time. By extension, the ability to learn includes the ability to gather, process and respond to these changes. The connections enabled through a network of humans and non-humans allow for the flow, management, analysis and synthesis of large bodies of information, which are constantly being changed into useful, actionable knowledge (Siemens, 2005b). This is the power of the network connections.

**Actor-network theory (material semiotics)**

Actor-network theory (ANT) as a theoretical framework or set of sensibilities originated in Science, Technology and Society (STS) studies, which draws upon a number of disciplines including ‘anthropology, education, geography, history and history of science, organisational analysis, philosophy of science and sociology (Law, 2008). STS has had a number of name changes over time including: ‘science studies’, ‘science and technology studies’, ‘the sociology of scientific knowledge’ and the ‘social studies of science and technology’. STS and its various developments have been located within broader political and intellectual debates, which the changes in name reflect, so the shifts in name are not insignificant. However, for the purposes of this study, we will simply state that ANT is a sub-set of the STS ‘tradition’ and as such adopts a *material* semiotic approach to understanding science, technology and society.

Material semiotics suggests that things and practices can be understood as signs and can, therefore, like words, be read as texts in context. In this endeavour, ANT does not limit itself to a study of human interactions but opens up the field of study to human and non-human entities, regarding the social and the material as co-constituting. Suchman clarifies this position drawing upon work by Callon:

The agents, their dimensions, and what they are and do, all depend on the morphology of the relations in which they are involved (Callon, 1997, p.4 cited in Suchman, 2001, p.6).

So within the network metaphor, the social and the material become the socio-material as they produce each other in relationship. The technical is never just the technical, nor the social just the social: they are mutually constituting. As realities are relationally produced, or performed, the focus of ANT studies is on *practices*. It asks: what work is being done, how is it being done, and to what effect?

Operating from a performative perspective, ANT argues that reality is not ‘out there’ or given in the order of things but is performed into being (Law, 1999). So teachers, students, web 2.0 technologies, the weather, IT help support systems, university policies, curriculum and pedagogic designs, wires, cables, the LMS, the university webpages and a myriad of other objects, people, ideas and procedures impacting on
online education ‘assemble and together enact a set of practices that make a more or less precarious reality [for a period of time]’ (Law, 2007, p.11). In this scenario, the teacher, the LMS and the web 2.0 technologies are relational effects rather than causes of online education outcomes. This marks a significant ontological distinction between ANT and social-constructivist positions. Social constructivism works from a position that the objects of its study are antecedent to the practices in which they take part.

**Actors and Agency**

ANT argues that entities take their shape from the relationships in which they are engaged. Thus, any meanings they make, any divisions, boundaries or edges that they produce, between themselves and other entities, and any other outcomes of their intra-actions (like teaching and learning), are network or relational effects. Agency then, becomes a distributed relational effect (Suchman, 2001).

**What is a network?**

ANT regards a network as an association of heterogeneous entities linked together for a period of time. The links form a mesh of connections which transform the entities into a net, or assemblage. However, assemblages do not always ‘hold’. Entities, belonging to multiple assemblages frequently resist this shaping process. In consequence, assemblages and their effects are not always predictable. Work is needed to stabilise relationships and fix identities, to exclude some while recruiting and holding others in place (Nespor, 1994). Indeed, a great diversity of entities is often recruited to support the efforts to stabilise. Actor-network theory seeks to open up to view the work that goes into building assemblages, to establishing and maintaining order and to shaping the entities and practices through which they are produced.

Teachers, students and their technologies are seen as enfolded in, and enacted by multiple knowledge networks. Similarly, ‘learning technologies’ are seen as emergent effects, caught up in webs of relations supporting multiple and even disparate knowledge practices simultaneously. In this way, material semiotics offers ways to understand learning as emerging from and distributed across multiple sites, not all of which are ‘contained’ within the university’s designated learning spaces, or designed as part of the teacher’s pedagogy and curricular intent. Within this framework, metaphors for learning, such as learning assemblage, seek to lift up to view the

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4 Feminist philosopher, Karen Barad (2003), uses the term ‘intra-actions’ in preference to ‘interactions’. She claims that the term ‘interactions’ presumes the prior existence of independent actors. ‘Intra-actions’, however, seeks to acknowledge the interdependence of objects and subjects, to recognise that the social and the material are co-emergent. This distinction represents a fundamental difference between connectivism and actor-network theory. They are ontologically at odds. For connectivism, the social and the material may come together in powerful ways, but they are independent of and antecedent to the practices in which they take part, while for actor-network theory entities are co-produced in the practices in which they are entangled.

5 The term ‘entities’ is used hereafter in preference to ‘actors’, as the term ‘actors’ has anthropomorphic connotations and as ANT stories practices as ‘more than human’, this would not do.

6 The term ‘assemblage’ is used in place of the term ‘network’ in more recent works emerging from the actor-network theory tradition (itself increasingly referred to as material semiotics) because assemblage captures the heterogeneity, permeability and chronic uncertainty of the collections of things and relations that constitute them (Law, 2009).

7 A student may also be a mother, a teacher, and a basketballer on the weekend and, on some weeknights, a computer may be not only an educational resource but also a recreational one. Similarly, a Learning Management System may be a part of a student portal, and/or an administrative system linked to the student records system.
multiplicity and complexity of the practices in which online learning in higher education settings is enacted or performed.

Further, a study of online learning as learning assemblage, lifts back to view the work being done to ‘hold’ online education together and to maintain student engagement. The work surrounding the maintenance of completion rates is a case in point. Social constructivist accounts of online education tend to singularise, to focus accounts of teaching and learning practices on the affordances offered to students by teaching designs, social technologies and students’ interactions. However, these three ‘affordances’ are often the result of complex sets of intra-actions (Barad, 2003) between a veritable army of entities, often discounted in social constructivist accounts of online education as a distraction from the real work done in the learning space by the teacher, the students, and the designated learning technologies. In consequence, and at a very practical level, if multiplicity and complexity are emptied out of accounts, then resourcing to support these activities could be grossly underestimated and thus put future efforts at online education at risk.

A learning story

Ted teaches a fully online subject: **Web-based Environments**, to a group of Masters of Education students. The students are geographically dispersed around the world and they work as education professionals in a range of education, health, community and commercial settings. The subject’s learning objective is that students will develop confidence in researching and developing an understanding of the educational applications of a range of contemporary web-based technologies, often referred to as Web 2.0 technologies or social technologies.

Ted’s teaching space is a subject website in the University’s Learning Management System (LMS), Blackboard. Ted considers the LMS technologies constraining and includes links in the LMS to a number of external web-based environments\(^8\) that he feels are more teaching/learning friendly and which reflect the sorts of tools his students are using elsewhere.

Ted teaches from a social constructivist perspective which asserts that students construct their own meanings through active experimentation, research, reflection and collaboration (Garrison & Anderson, 2003; D. Johnson et al., 1981; Richardson & Swan, 2003; Windschitl, 2002). Accordingly, he requires his students to maintain weblogs (blogs)\(^9\) – in web 2.0 terms - personal learning environments – as reflective journals and to add comments in the LMS discussion forum. He also invites the students to a weekly online chat session. These activities are conducted in web-based environments outside the LMS but ‘appear’ collocated with the LMS, an effect which is ‘engineered’ via an external link capacity built in to Blackboard. Thus, the student blogs and the portal to the online chat environment all ‘sit’ together side-by-side in the LMS.

Some students choose to link their existing professional personal learning environments to the LMS rather than to maintain separate subject blogs, which broadens the field of comments and information made available to those students who read their posts. Ted welcomes this broadening out.

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8 These are freely available open-source tools many of which are commonly used by students in their workplaces, schools and at home. They are familiar to the students and are regarded by Ted, and his students, as offering greater flexibility than the LMS.

9The weblogs programs students might use include: Blogger, Edublogs, Wordpress, or Livejournal which they are asked to link to the subject’s LMS website.
One assessment task requires students to research and describe, via their blogs, the educational applications of a Web 2.0 technology. As the majority of Web 2.0 technologies have not been designed for educational application in the first instance, this activity proves professionally very useful for the students. However, as the semester proceeds, the task of logging into and wading through the posts in 15 blogs proves an onerous one for the students. An experienced online educator, Ted explains, early in the semester, how students might set up RSS feeds\(^{10}\) to the blogs, to reduce the workload of accessing other students’ posts.

The RSS feeds require the students to access a widget in the blogs, which proves to be difficult for some students, despite Ted’s efforts to explain the process via the subject blog and a video clip. However, one persistent student works it out by comparing the blog RSS process to the RSS feed feature on his Facebook\(^{11}\) page and tells the other students how to do it.

The following exchange in the subject discussion forum, gives some insight into how the students went about working out how to use the RSS feeds:

“Tricky little thing”
Post on March 27th, by Mary\(^{12}\)

I have successfully added everyone onto my blogroll, however finding it very hard to add a RSS feed. I’ve looked at the videos that are posted [by Ted] and still cannot work it out. I will soldier on!!

One Response to “Tricky little thing”
Posted on March 27th, by Kim

Hi Mary. I had a lot of trouble too but managed to work it out in the end. I put up some instructions in my blog. Hope they help.

Kim.

Kim offers a blog post on how to set up RSS feeds with a cute image included:

“Really Simple Syndication”
Posted on March 27, by Kim

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\(^{10}\) RSS stands for Really Simple Syndication, which, in this case, proved not to be so simple! RSS allows a person to tag a website so that it automatically sends new posts on that website to their personal email address, blog or website. The RSS feeds, as these automatically sent posts are called, can be set up to be quite selective, choosing only certain types of posts to be sent through.

\(^{11}\) A number of students in Ted’s class talk to each other regularly about the subject via Facebook. They talk about the subject outside the subject LMS space, performing Facebook as ‘easier to follow’ than the subject discussion forum, and ‘more private’ (they don’t always want Ted to see what they say about the subject, nor to appear ‘dumb’ by talking ‘in front of him’ in the LMS blog space).

\(^{12}\) Pseudonyms are used for all students named in the data story.
Well it wasn't as easy as I thought it would be, but I've finally managed to get an RSS feed into my Edublog 😊.

An RSS, as I understand it, is a great way to follow numerous websites in one place without having to check them all individually. I can see a parallel with [my] current Facebook layout. When I first used Facebook, about two years ago, you had to check each person’s page to see what they had updated. With today’s version of Facebook you can see everyone’s updates in one feed.

Getting an RSS into Edublogs was not easy, and I thank Bess [another student] for all her help. For anyone who wants to insert an RSS into their Edublog this is how it’s done:

1) You need to sign up for Google Reader.
2) Click ‘Add a Subscription’ and add all of the sites you want to appear on your RSS
3) Click on each of the subscriptions and click ‘Share’ for all of the posts you want to appear in your RSS. Google Reader will indicate all new posts
4) Click ‘Shared items’, ‘sharing settings’ then ‘Add a Clip’. Select the hypertext that appears and copy to your clipboard
5) In Edublogs Dashboard click on widgets and add a text box
6) Copy the hypertext into your textbox and it should appear in your blog

“Fantastic”
Post on March 28th, by Mary

After hours of frustration I received a comment from Kim explaining how to set up a RSS feed! Hallelujah! Thank you so much Kim. So it seems it wasn’t just me finding it hard, Kim also found it hard. Now I have to figure out how to use it and utilise it to my advantage. Already I have found interesting feeds relating to technology and schools.

Kim’s instructions take the students in a direction Ted had not intended but the broad outcome is what he was hoping for, so he doesn’t intervene. Once the RSS feeds are set up, students are sent the latest posts in their favourite blogs as soon as they are posted. This deals with the workload issue to some extent.

In the course of the subject, the students are asked to discuss the value and uses of web-based learning objects (web-based curriculum tools) in the subject discussion forum and weekly chat session. One student has an extensive IT educators’ professional network with which she keeps in touch via Twitter. She chooses to send a question to this network regarding learning objects. When the network members respond with enthusiasm, she collects the responses, distils the main themes and sends out another question. The student goes through several send/analyse/distil iterations to come up with a well considered and researched response to the discussion topic and submits it for consideration by the group, declaring her ‘research’ methodology. As the student had used a web-based environment with great effect to answer the weekly discussion topic, Ted believes she has provided a rare example of

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13 Twitter is a mobile text-based communication system which allows the sharing of ideas and information to a maximum length of 140 characters per post.
a student response which not only extends the student’s learning but acts as a clear demonstration of her having achieved the course objectives. He praises her efforts in the weekly chat session.

The university does not uniformly provide remote access to its servers for academic staff. Subsequently, Ted has to use his family’s internet connection when he works from home. Generally his home access is adequate for his family’s needs. However, when he is hosting a Skype chat session with 15 students, Ted needs more bandwidth than is consistently available through his home internet subscription. One evening at home, while hosting a Skype session with his students, Ted loses the connection to the university’s server. So he grabs his laptop and his Bluetooth phone and heads to the local McDonald’s car park. With no other way to reconnect to the Skype chat session, he knows the fast food chain has wireless access to the internet that extends into its car park. So he sits laptop and hamburger in hand, Bluetooth in ear, and reconnects to his students to continue what proves a very fruitful discussion. McDonald’s, for the time that Ted sits in their car park, is performed as part of the university’s online network and is refashioned as learning space.

At the end of the subject, students are asked to write a reflective report about what they have learned during the semester, as noted in their blogs. By the end of semester, students have written many posts and received a multitude of responses. There is a lot of reading to do. Ted suggests they set up tag clouds to assist with the analysis task. Tag clouds allow the students to predetermine a set of words, which have significance for them and the ideas they may encounter during the semester. The tag cloud then conducts a linguistic analysis of the blog it is set up in and creates a visual image of the words used that match the predetermined set, enlarging the size of the words which have been used more often. This gives the students some indication of what thinking has occurred for them during the semester, as expressed in their blogs. The tag clouds, like the RSS feeds, assist students to access and analyse large and diverse bodies of information as well as aid in reducing workload.

The preceding data story reveals a number of un/intended effects of teaching and learning interactions supported by ICTs. It is these effects which have led the authors to develop the current paper.

Discussion

Connectivism: Online learning as socio-material connection

Social constructivism, emphasising the importance of the social interactions between students in networked spaces, might view the multiple blog postings as a sign of a healthy online discussion, where students explain, elaborate, solve problems and defend their positions to each other through their postings and comments (Windschitl, 2002). It might view the RSS feed aggregators simply as a pragmatic and handy solution to managing the volume of posts coming from disparate web-based blogs.

Connectivism recognises that in an environment characterised by large volumes of text-based interactions, the capacity for sifting and summarising information means the technologies of RSS readers, tag clouds and the blog environments themselves, work together with the students to constantly refresh and build updated patterns in complex arrays of information coming at rates unprecedented in face-to-face classroom discussions. In other words, these technologies participate in the learning process by providing not just a solution to managing volume but also organisation,
filtering, access and connections via the software. They enable a real time flow of updates and pattern generation from other blogs, online databases and other reference sites which participate with the student in filtering and maintaining the connections to these nodes or extended networks (Siemens, 2005a).

The technologies of RSS feed aggregators and tag clouds not only make the learning possible but the accuracy, currency and patterning are, in this case, part of what the connections produce as knowledge that can be actionable as learning. RSS feed aggregators don’t just allow students to access new posts quickly, they feed new posts into the sites that are subscribing and set up connections that allow for timely responding and commenting. In later stages the students recognised the potential of feeds from other sites of interest, outside the immediate network, and began feeding the updated content of these pages into the subject’s network.

In a microcosm of the new demands of a highly connected networked society, the methods adopted by the students for developing quick overviews and access points to the complexities of multiple posts, meant that the tag clouds and RSS feed aggregators worked to summarise, organise, display and link to large bodies of information much more quickly than the students could have done on their own. In so doing, the technologies also served to speed up the students’ capacity to scan the incoming information flows and to be discriminating in what they looked at more closely.

Social constructivism would place a greater emphasis on the importance of social interactions in effecting personal learning, but connectivism would suggest that the learning or knowledge building was not possible without the pattern recognition capability of the tag cloud application and the increased scanning capacity and speed of access provided through the RSS feed aggregators.

At the level of network formation, Siemens (2005a) asserts that once a connection is made “information flows more freely”. The most obvious principle that feed readers activated for learning is the principle of currency of knowledge that would be difficult to duplicate without assigning some of the “learning work” to the software and the network. Similarly tag clouds externalise the learning in the technology and produce up to the minute patterns of the frequency with which topics are mentioned. In both RSS and tag clouds, there is evidence that connections are making possible learnings and recognitions that are not readily available without the workings of the network.

**Actor-network theory: Online learning as emergent assemblage**

ANT accounts are interested in studying practices, like teaching and learning, to gain an understanding of how entities come together, or assemble, and to what effect. How is learning told in assemblage accounts?

Working from a relational ontology, material semiotics would consider Ted’s online subject as ‘not real’ until enacted into being (Law, 2009). In order to understand online learning, material semiotics traces the heterogeneous socio-material practices that perform and produce realities, like learning, and in doing so affords a view of learning as emergent, not as designed, but as assembled (bundled together) in the minute by minute, flow of action (D. Mulcahy, Forthcoming, p.10), as shown in the data story above.
In adopting an assemblage analytic to examine learning, one becomes sensitive to materiality and multiplicity. There are multiple learning spaces overlapping and connecting in Ted’s online subject. The university performs the learning space as regional, bounded by the Learning Management System and protected by passwords. The knowledge imparted through the lecture notes and Powerpoint slides, the reading lists and resources held in the LMS subject’s content management system and the university’s digital repository are performed as ‘canonical disciplinary knowledges’; a set of knowledges available to everybody in the class to use to inform their developing professional practice. This ‘reference’ material enacts a representational form of knowledge (Sorensen, 2009), a form of knowledge that sits ‘out there’, as independent of students’ opinions and beliefs. Students are expected to read the lecture notes and reading resources, and to contribute to the LMS discussion forum to demonstrate their developing understanding of the subject material. The subject resources are performed as ‘new’ for Ted’s students and the university casts them as ‘foundational educational theory’, as authoritative, as material that must be engaged.

However, what we see in Ted’s online class are students moving beyond these pre-existing representational knowledges and regional spaces to ‘not-university spaces’ and to ‘practice as embodied educational theory’. The students, as practising teachers, perform other learning spaces, other learning theories, professional networks and embodied practice as additional valuable sources of disciplinary knowledge (Cheetham, 1999; Eraut, 2000). Here learning is re-cast as informal, practice-based, as well as informed by theory.

When the RSS feeds won’t work, students abandon the LMS and go to Google Reader to find a way to make things work. They talk to each other via Facebook to discuss their difficulties with the online technologies away from the gaze of Ted and the university and together find solutions. They use Twitter to see what their professional colleagues, whom they trust, think of learning objects, as well as read numerous articles by unknown practitioners who speak too highly, perhaps, of technical solutions to complex curriculum issues. Kim, a student in Ted’s class, is also a teacher; while he listens to Ted’s Skype session, he eats his dinner with his family and emails his principal about the outcomes of the curriculum meeting last week.

Here there are multiple intersecting spaces and knowledges. Students don’t move across these multiple spaces, nor between these knowledge forms; they inhabit and enact them simultaneously, connecting them together, drawing from them as needed to build disciplinary knowledge/s and inform professional practice. Multiple knowledges and spaces are co-performed and fluid. While Ted moves to the McDonald’s car park for the lack of remote server access, the university’s learning space moves with him - from his office, to his home and then to McDonald’s, while the students remain at home or at work listening to his Skype discussion. And while the university sits in the car park with Ted, it shares home spaces with the students. In/formal cohabit. Relations in one form of knowledge may be involved in another as well, and parts and relations of one space can participate in another (Sorensen, 2009, p.181). These are fluid spaces, performing and sharing different forms of knowledge. They are not singular, bound in the regional spaces of the LMS, but leak and bleed to good effect. Students learn. The learning technologies (machine and pedagogies) confound and contribute to allowing the flows between spaces and forms of knowledge.

One could be overwhelmed by the loose ends, the technical glitches, the apparent chaos, but these tensions are the necessary effect of engagement and multiplicity and they are productive.
Ted embraces multiplicity. He is comfortable with spatial variability, and accepts multiple forms of knowledge as the way things are. Perhaps for Ted learning has always been in/formal. He encourages the students to draw on lived experience, knowing that professional practice emerges from a mixture of theory and practice. He offers them RSS feeds and tag clouds because he knows they inhabit multiple spaces, with commitments to numerous networks and that juggling multiple memberships is tricky. The RSS feeds and tag clouds help the students to access and synthesize large amounts of information generated in their blogs and discussion forum posts, and he hopes these technologies will help. But it is never entirely possible to set up technologies that unambiguously and consistently perform as they are designed. So when the students work out alternative RSS feeds, Ted accepts this. The pattern of relations between Ted, the students, the assortment of learning technologies, servers and internet connections is performed as regional by the university, which assigns grades to the students for the work they have submitted on time and it empties out variability. But it is spatial variability and an acceptance of different forms of knowledge, which has ensured that these online students were able to enhance their professional practice through participation in the subject, and to achieve the learning outcomes.

Adopting a socio-material perspective, as actor-network theory does, we lift back to view the specificities and heterogeneity of learning practices, the multiple forms of knowledge and spaces, as well as the many people, machines, software programs and environments - the diverse others\(^\text{14}\) that take part in this multiplicity and are co-implicated in it.

When surfacing the multiplicity and complexity of online teaching and learning arrangements, when examining how the assemblage comes together and holds in place, falls apart, or stumbles momentarily, it becomes evident as to what forms of knowledge, and learning spaces we may need to accommodate and what materials and activities we may need more of. Students, teachers and curriculum planners could then start engaging (and enabling/resourcing) the different forms of knowledge and learning spaces and the ways in which these can contribute to developing professional practice/s and disciplinary knowledge/s.

**Conclusion – Connectivism and Actor-network theory - New metaphors for learning**

Both actor-network theory and connectivism allow for a more symmetrical account of the interplay between human and non-human relations in networked learning. Both understand online education as a socio-material affair where knowledge practices emerge from the interactions between humans and nonhumans.

Connectivism seeks to lift back to view the pivotal and constitutive role of technologies in promoting learning in networked spaces. It insists that with web 2.0 technologies, the technologies are essential to the learning experience; there is some merging of the learner with their tools in networked environments. The technologies so enhance the learner’s capacity to receive and process large quantities of information that to ignore their important role in networked knowledge practices would be short-sighted. In this sense, social technologies connect with the learner to provide unprecedented opportunities for learning to flow across the connections in networked spaces, much as calculators were shown to do for physics students at MIT in the 1980’s (Turkle,

\^\text{14}\) Paying analytical attention to the objects entangled in learning practices ‘reveals their centrality to the various processes and practices of learning and knowing’ (Ewenstein & Whyte, 2009, p.8).
1995). It is these human-machine connections, which are critical to connectivist accounts of networked learning.

As actor-network theory has it, ‘learning’ is a relational effect of socio-material practices. There is a lot of work behind the scenes, much tinkering, and some complaining off-camera in the name of ‘getting the work done’. There is even some side-stepping of the ‘official route’, a by-passing of the LMS, used as portal to other ‘not-university’ spaces and there is re/appropriation (Akrich, 1992; Suchman, 2005) – workspaces, lounge rooms and fast food outlets are recruited in the service of the university. Heterogeneous entities, including multiple learning spaces and multiple forms of knowledge, produce online learning. And in the end, the students ‘get it’ and do ‘good work’. There is no attrition and the subject holds together. There is multiplicity, complexity and a lot of work to make it hold.

Members of learning assemblages may not all be there by design; there may be no need for consensus of opinion about how to ‘get things done’ or a vision shared by all the implicated entities (Star, 1989; Star & Greisemer, 1989). There may be no finished product with neat and tidy edges (Mol, 2002). Perhaps online learning assemblages can with profit be thought of as practices involving heterogeneous entities that come together, for a time, to produce ‘useful learning’. However, assemblages require a deal of work\textsuperscript{15} to gather and hold the disparate entities together, requiring an ‘ethics of care’\textsuperscript{16} (Mol et al., 2010; Winance, 2010), continual vigilance, and much tinkering.

Connectivism suggests that it is the interconnections between humans and non-humans which produce learning. It suggests that once the technologies are working, learning flows between the humans and the non-humans with relative ease. This is a simple tale, where the specificities of teaching and learning practices, the heterogeneous entities, the re-inscription of knowledges and spaces, the endless breakdowns and repair work are bracketed out. Conversely, actor-network theory, paying close attention to the specificities of teaching and learning practices, insists that learning is the effect of complex arrangements between diverse entities, requiring a series of ongoing re/negotiations and heedful attention. It acknowledges that where a university supports an ‘ethics of care’ in its professional practices, provides adequate resourcing, and leaves learning spaces open, learning assemblages can expand, contract and flow in response to issues as they arise, to find a way to produce useful learning despite, and perhaps because of, complexity.

\textsuperscript{15} This work must be acknowledged for it is not insignificant and requires adequate resourcing, time, money, skill and much patience.

\textsuperscript{16} Mol, Moser and Pols (2010) define an ‘ethics of care’ as a relational practice where practitioners work with their clients, their technologies, and other materials with attuned attentiveness, meticulously exploring (in a world full of complex ambivalence and shifting tensions), until a suitable arrangement is made and a way to go on is found, not necessarily to make the situation perfect, but to make it better. This is not an individual effort but a collective endeavour relying on experience, expertise and experimentation. In the above data story, Kim and Ted exercise an ‘ethics of care’.
Bibliography


education: the social construction of academic computing (pp. 37 - 64).


