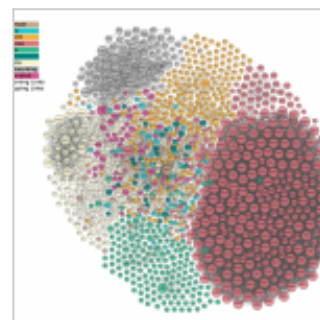# Connectivism, semantic web and sentiment data for smarter learning

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Some key quotes and papers on why thinking about a Connectivist inspired pedagogy for smart learning leads to thinking about the knowledge web. How we may need to transform the way we manage and organise this vast resource from a technological perspective as well as more conventional educational perspectives. The need to think in more inventive ways about knowledge in the networks, how to manage and 'record' the digital histories of each knowledge node and how to advance learning analytics and data tracking to be more pedagogical in nature, not merely glorified web analytics[1].

NB Boxes in blue are my thoughts and comments.

Rita Kop (2012)

Kop makes some very relevant argument about findability and knowledge web structure in this paper.

"Google accounts for 72.15% of all searches in the USA (Experian Hitwise, 2010) and 90% in the European Union (White & Campbell, 2010), which makes Google's behavior and its integrity in relation to the access it provides to information crucial to networked learning. It might be a little naïve to expect a search engine to behave in the best possible interest of the searcher, after all as Grimmelmann explains:

Search engines are attention lenses; they bring the online world into focus. They can redirect, reveal, magnify, and distort. They have immense power to help and to hide. We use them, to some extent, always at our own peril. And out of the many ways that search engines can cause harm, the thorniest problems of all stem from their ranking decisions. (Grimmelmann, 2010, p. 435)

… As educators it seems to become vital to assess the best possible ways to collect information and voices can be heard advocating a publicly funded search engine, rather than one controlled by commerce to avoid bias in the searches we carry out (White, 2010, Goldman, 2010). As White argued compellingly:

The danger of allowing an advertising company to control the index of human knowledge is too obvious to ignore. The universal index is the shared heritage of humanity. It ought to be owned by us all. No corporation or nation has the right to privatize the index, commercialize the index, censor what they do not like or auction search ranking to the highest bidder. We have public libraries. We need a public search engine. (White, 2010:1).

While it is laudable to think of a 'publicly funded search engine', this statement perhaps indicates gaps in knowledge about what is potentially technically possible on the web (though it was made in 2010) and how to solve this dilemma. Of course one can have another search engine – in fact open source search engines had existed for some time (e.g. https://en.wikipedia.org/wiki/DMOZ). But this does not solve the problem.

(Arguably) if we think in terms of apps and websites, we fail to understand these are not what will ever make a difference. We must perhaps now think in terms of what happens BEFORE any app or website is involved in the chain of information delivery, but maybe within an open access scenario of knowledge networks, i.e. those outside paywalls. The work referred to later in this article on Linked Data is very relevant to this.

... Barabasi looked at the mathematics of the Internet and Web as networks and found that they do not perform as "random" networks, but as "scale-free" networks. The difference would be ruled by two characteristics: "growth" and "preferential attachment", showing that this type of network grows "one node at a time" and that a node must "choose" to what other nodes it will connect. However, at the same time, the more connections a node has, the more likely it is that other nodes will attach to it (Barabasi, 2003, p. 86). [...] The early adopter nodes attract a multitude of other nodes, but it is not necessarily their value that is attractive, more likely their popularity and attraction to others. [...] Barabasi's research shows that networks are not neutral, which is also emphasized by Bouchard (2011a). Barabasi found in his research that participants on networks are not only selective, but that the nature of networks and the "power curve" prevents network "surfers" from having access to all information at the same level.

Even though it seems on the surface that people have access to any piece of information and resource they would like on the Web, in reality this access is restricted by the structure of the Web and by the ranking of information by search engines(Grimmelmann, 2010; Goldman, 2010). [...] ...the need for high levels of critical capabilities, in addition to knowledge of the sub-systems of the Web, are important to be able to access information and resources that are relevant and required to advance learning. [...] My own research (Kop, 2010) shows that it is the presence and involvement of (knowledgeable) others in an environment characterized by many technological variables and contexts that help learners to make sense of the multitude of resources offered on the Web. In the absence of adult educators, it is imperative to harness the changing affordances and potential of new technologies to this extent."

Kop goes on to discuss serendipity – the importance of the unpredicted result to throw the proverbial spanner in the works thereby potentially changing the course of thinking (and knowing) for the better. 'Thinking outside the box' via assistive algorithm, as search results affect what we find and then what we consequently search for next (Morville, various).

George Siemens (2006)

Siemens whole raison d'être might be described as attempting to reorganize and structure the knowledge web for learning. These quotes are taken from his book "Knowing Knowledge". (He has very recently published with co-authors a "Handbook of Learning Analytics", Solar 2017, referred to later in this article.)

"Organization today consists of dynamic networks and ecologies—models capable of adaptation (adjusting and reacting to changes)." p21

"Tools today serve a purpose that is largely based on the "old" model of library catalogue and encyclopedia. As categorization (and finding) models, they serve a purpose when we have a one-dimensional relationship to knowledge (namely that we understand we need it and, in the process, seek to acquire it). What happens when software/technology does this for us? What happens when the knowledge we require is presented to us without having to consciously seek it (artificial intelligence)?" p55

" Once knowledge is more tightly integrated in contexts of use, we can shift more attention to the act of application. We need to move beyond finding and evaluating relevance, to use and application." p56

"Perhaps the challenge with informal learning is the many different approaches a learner might take (how can we plan and design for it?). Perhaps even our notion of design is worth rethinking—do we design learning? Or do we design environments in which motivated learners can acquire what they need? Yet if we cannot impose some type of order on the process, is it really design? Will corporations invest in a learning theory that is not strongly tied to strategic goals?" p119

Siemens I believe is making an important point here about the proprietary nature of learning platforms – the VLE enterprise market is enormous and growing. And yet it will not solve the issue of information delivery in smart ways, as can only retrieve the information that resides in the networks in terms of data and metadata embedded in those nodes. A VLE can develop

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clever search algorithms but it cannot obtain a 'smart pull/push' of retrieved data, because that data (knowledge nodes) does not have relevant learning meta embedded within it. Even if exceptional in search and retrieve capability, it is only as good as one platform can ever be. What about everyone else? And who owns this miracle platform, and who owns the learning and teaching data generated by it? (See Ben Williamson, various.)

Another point about learning design. My tutor and I discussed this again recently (in relation to the title of the thesis and the pedagogical framework) and I proposed that there is no such thing as learning design, and even if there was before (before 'the web' or before web 2.0), there isn't now. It's therefore encouraging for me to see that Siemens seems to also think this. At the most we design an environment for learning, and that environment needs to be very flexible and fluid for truly 'smart' learning to be available to the learner as well as the learning facilitator.

Ingrid Carreño (2014)

Carreño's paper focuses on the 'theory of connectivity', and argues that Connectivism is a vital component of understanding the dynamic knowledge web as an efficient and effective learning environment.

"Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories. […] Learning […] 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" p7

""Connectivism also addresses the challenges that many corporations face in knowledge management activities. Knowledge that resides in a database needs to be connected with the right people in the right context in order to be classified as learning." p9

"…an additional element in understanding learning models in a digital era (is) "quantum theory of trust" which "explains not just how to recognize the collective cognitive capability of an organization, but how to cultivate and increase it" p8

"Connectivism not only builds on the earlier notion of connectionism from computer science but also on the idea of situated cognition [38], that knowledge occurs not only in the minds of individuals; but rather, is supra- and trans-individual and also exists within and between groups. Its heritage also includes that of collective intelligence…" p8

Carreño's work is very useful. Though the english isn't great her points about supra-individual knowledge are the reason I found her in the first place. Connectivist epistemology is uniquely significant because of its assertion about the learning in the system, that this learning is learning like any other, and our (human) learning to navigate this system of learned knowledge is part of a new theory of learning. Carreño argues this on several complex levels.

I believe that by developing the (non-human) system intelligently, we develop the learning of the system, and can manage and organise that learning. The system therefore needs to build digital residue histories of each node (like a neural network), similar to how Bruce Sterling described the Spime (see his work on RFID and Spimes from around 2004/5).

This also chimes perfectly with Morville's discussions on the Noosphere and collective wisdom. "What we find changes who we become".

Al Dahdouh et al (2015)

There's an immense amount in this paper. But the description of the neural network from a variety of perspectives is particularly invoking of 'smart knowledge ties'.

"…The node refers to any objects that can be connected. Connectivism recognizes three node types: neural, conceptual (internal) and external (Siemens & Tittenberger, 2009). In the neural level, the network consists of neurons connected by neuron's axon and dendrites (Stufflebeam, 2008). In the conceptual level, the network consists of concepts, ideas and thoughts connected by conceptual links like similarity and positive correlation. In the external level, the network consists of people, books, websites, programs and databases connected by internet, intranet or direct contact…"

"..The relationship between nodes is not necessarily sharp. It is sometimes interpreted or graded. For example, consider a relation of 'friendship' between two persons. It is clear that the friendship is not a quantitative relationship. Instead, it is interpreted, graded or, even, contains sub-relationships. In this case, 'friendship' is considered as a 'tie'. … Direction: The direction of the relationship makes a difference. Some relationship is reversed when you flow from one node to another. …"

"… the node is described merely as a black box or an ambiguous object. Connectivism argues however that the node itself is a network. "Every entity is composed of additional entities" (Downes, 2007). The entity can be viewed in three separated levels:.. " (Neural, Conceptual, External.)

"… Conceptual level – The node in this level is the concept. The concepts refer to ideas and thoughts that help human beings to interpret the world. For example, consider the 'liquid' concept. Actually, there is no physical instance named 'liquid'. The liquid is just a concept in human mind to gather relatively similar instances such as water, oil and ethanol. All these instances have something in common which makes them gather under one same concept: 'liquid'…."

"…Creating a single node to represent an aggregation of different nodes simplifies human's network of concepts. The idea of aggregation returned to a philosophical idea of associationism: "two things that are relevantly similar become connected in the mind. This connection or association in turn allows knowledge about one to be inferred of the other" (Downes, 2007). "

The description of the conceptual level echoes the entailment mesh/structure model of 'a representation of an epistemological domain' (Pask, lecture 1980, video). When the conceptual level description is interpreted as smart, we see the possibility of strong and weak tie epistemological domain relationships. In the 'liquid' example, you might think instead of pedagogy, and topic, EQF level or learning activity type as parts of the 'epistemological domain entailment structure' of pedagogy . These are 'concepts', they do not actually exist. But they are a bounded group (or set) of factors to indicate a controlled set of associated phenomena (i.e. not a folksonomy). These other phenomena (sub topic, keywords, location, age, IPR, …) provide granular further conceptual relationships for additional 'selectivity' of knowledge node for push or pull adaptive provision. This also indicates that there is potential to capture these relationships (pedagogical – or epistemological) as a digital history residue, building strength and weakness into 'smart knowledge' ties both within and between nodes.

"The idea of aggregation" is similar in nature to entailment, things becoming connected, and knowledge about one being inferred to the other. I am thinking of non-human cognisant agents, not human or actively human connected, but over time, non-human connected 'aggregation'.

"…External level The flow of information at the external level comes as a form of social connection. The social studies of science and technology have revealed that the node (which may be human or non- human) is socially connected to its environment in a network based "topology". The node has a unique position in the network. Hence, it can only see, perceive, send and receive information through this position. The position in the network (centrality), the number of direct connections (density), the importance, or the uniqueness, of a connection to other nodes (bridge) and the minimum number of connections needed to reach a target node (distance) are all subjects of analysis in Social Network Analysis (SNA). What really flows through these connections does not matter, from SNA's perspective, as the frequency, repetition and availability of messages. In other words, SNA does not usually analyze the content; it analyzes the maximum, the minimum, the average and the total number of messages between nodes."

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This section about flow of information at the external level is also thought provoking. Does this mean we can only see relational knowledge nodes and 'value' through the network that any given node resides in?

Or, can we connect with each node individually by creating an API, for example, that works on the principle of non-relational data Unique Identifier (NoSQL, like MongoDB), bypassing its network position and relational ID. This in turn would generate intelligent (pedagogical/epistemological) digital residue connections with other nodes that reside in other networks. I would expect this to be technically possible. Perhaps this is creating a 'super-network' and maybe that 'network-of-networks' may still behave as described above. But, perhaps non-relational databases (e.g. MongoDB) do not work like other networks.

This way of dealing with data has become far more significant in more recent (technical) application development. The reason being, to connect directly to a node that is held 'non-relationally' is much faster than through a set of pathway node relationships. In this sense, though knowledge networks may all have their own relational design and connections, these 'self-contained' relationships become irrelevant if one is connecting from outside – through a Smart Knowledge API protocol, for example. I would call this concept the 'Smart Knowledge Web', connecting via API key and secret to pull in or push out data calls or make permanent connections (like the Metaweblog API, for example) for publishing shared content. These data calls and knowledge architecture would use Smart Knowledge Web Language to describe node content and attach or call sentiment data to nodes via the API.

Social Network Analysis, while perhaps applying to (some of) the generation of learning residue, is not what Smart Knowledge is. Smart Knowledge needs to address the content, that is the whole point – to not only organise in epistemological ways, but to record a 'history of node behaviour' for each knowledge node – how it has been used, by who, for what kind of learning, etc., and how valuable that use was.

Liu et al (2016)

Four principles of smart learning:
"1. Awareness and adaptive technology: Context awareness technology, and learning adaptive technology by using the basic information of learning time and space in the smart learning framework;
2. Assessment and support technology: Teaching assessment technology and technology supporting by using the basic information of instruction in the smart learning framework;
3. Tracking and analytic technology: Dynamic tracking technology and learning analytic technology by using the basic information of learning activities in the smart learning framework;
4. Organization and reconstruction technology: Knowledge organization and reconstruction technology by using the basic information of learning content in the smart learning framework."
The factors that Lui et al outline here reflect a certain ambivalence toward what is *actually* meant by 'context awareness technology, and learning adaptive technology', 'technology supporting by using the basic information' and 'knowledge organization and reconstruction technology'. The way I interpret these concepts are that technology (as Lui et al refer to it) is smartly adaptable and organised for learning and teaching. This means that mechanisms are required to measure and record node and network behaviour relevant to pedagogical (guide for learning) uses, and that networked knowledge should be enabled for organisational – web ontology – systems that are adaptive for pedagogical purpose.

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Handbook of Learner Analytics

Chapter 29: Linked Data for Learning Analytics: The Case of the LAK Dataset.(Taibi & Dietze).
"The LAK (Linked Analytics and Knowledge) dataset provides access to a near-complete corpus of scholarly works in the LA field, exposed through rigorously applying LD principles. As such, it provides a focal point for investigating central results, methods, tools, and theories of the LA community and their evolution over time"

Chapter 30: Linked Data for Learning Analytics: Potentials and Challenges (Zouaq, Jovanović, Joksimović, Gašević).
"For instance, Heath and Bizer (2011) propose an educational graph across UK universities, comprising knowledge extracted from the content of learning resources. Given the development and use of knowledge graphs by an increasing number of major companies such as Google, Microsoft, and Facebook, the potential and possibilities opened up by such graphs for learning should be examined (Zablith, 2015)."
"Linked data has the potential to become a de facto standard for sharing resources on the Web (Kessler, d'Aquin, & Dietze, 2013). It uses URIs to uniquely identify entities, and the RDF data model1 to describe entities and connect them via links with explicitly defined semantics."

The scope of these two chapters (29, 30) talk in close similarity with the proposal I've discussed in a paper submitted to ECEL October 2017 regarding Smart Knowledge Web Language. I was not aware of these chapters when I hashed out my ideas but since then have discovered this and additional work that supports my assertion about needing to look beyond a pedagogical framework 'of itself', and attempt to move into a smart pedagogy that works 'technically' as well as pedagogically (as a guide to learning). My idea is somewhat different to their work in several ways, though in similar territory albeit from another (new) perspective.

Sentiment Data for Learning Effectiveness

Ideas about sentiment data for learning (as oppose to data about user tracking) are available in the literature but on first research my impression is that 90% of these discussions are about automated measurement of positive and negative words, in the way that social media would approach this. Further looking in relation to learning effectiveness measurement appears to proffer complex over elaborated methods of metric constructs such as those in chapter 22 of the Handbook of Learner Analytics (Mirriahi & Vigentini, 2017).
My interest lies in conceptualising how we can introduce learning design and effectiveness measurement (and smart delivery) through two or three separate mechanisms –

- *The 'smart learning activity report'* as reported by the learning facilitator. This associates activities with knowledge nodes and also, if meta-tag data is available, for pedagogical and subject domain factors, and could also be also geotagged (ie using SKWL meta concepts).
- *The 'smart learning report'*, submitted by learners either voluntarily or as part of their reflective exercise. This report is geotagged and activity tagged (so also creates a network tie to each knowledge node in that activity) to be mapped anonymously of learner UID to create maps of learning effective activities and knowledge nodes.
- *Simple learning effectiveness ranking/sentiment links* can be provided – useful/recommend/enjoy etc (aka 'Learning React' buttons)

Material for analytics specifically:

(Handbook of Learning Analytics)

- Chapter 20: Applying Recommender Systems for Learning Analytics: A Tutorial. Fazeli, S., Drachsler, H., Peter, S.
- Chapter 21: Learning Analytics for Self-Regulated Learning. Winne, P.

Relevant new sources for argument of direction (to use something like Smart Knowledge Web Language plus learning effectiveness ranking/sentiment) are ongoing.

Sources and other key papers:

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Footnotes

[1] Learning analytics (LA) and web analytics (WA) have a lot in common from the perspective of tracking and goal conversion. Much research exists in relation to making LA more informative in relation to actual learning effectiveness.

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