COMMUNITY TRACKING IN A cMOOC AND NOMADIC LEARNER BEHAVIOR IDENTIFICATION ON A CONNECTIVIST RHIZOMATIC LEARNING NETWORK

Aras BOZKURT
Ministry of Education, Eskisehir, Turkey

Sarah HONEYCHURCH
University of Glasgow, Glasgow, Scotland

Autumm CAINES
Capital University, Columbus, Ohio, USA

Maha BALI
American University in Cairo, Cairo, Egypt

Apostolos KOUTROPOULOS
UMass Boston, Boston, Massachusetts, USA

Dave CORMIER
University of Prince Edward Island
Charlottetown Prince Edward Island, Canada

ABSTRACT

This article contributes to the literature on connectivism, connectivist MOOCs (cMOOCs) and rhizomatic learning by examining participant interactions, community formation and nomadic learner behavior in a particular cMOOC, #rhizo15, facilitated for 6 weeks by Dave Cormier. It further focuses on what we can learn by observing Twitter interactions particularly. As an explanatory mixed research design, Social Network Analysis and content analysis were employed for the purposes of the research. SNA is used at the macro, meso and micro levels, and content analysis of one week of the MOOC was conducted using the Community of Inquiry framework. The macro level analysis demonstrates that communities in a rhizomatic connectivist networks have chaotic relationships with other communities in different dimensions (clarified by use of hashtags of concurrent, past and future events). A key finding at the meso level was that as #rhizo15 progressed and number of active participants decreased, interaction increased in overall network. The micro level analysis further reveals that, though completely online, the nature of open online ecosystems are very convenient to facilitate the formation of community. The content analysis of week 3 tweets demonstrated that cognitive presence was the most frequently observed, while teaching presence (teaching behaviors of both facilitator and participants) was the lowest. This research recognizes the limitations of looking only at Twitter when #rhizo15 conversations occurred over multiple platforms frequented by overlapping but not identical groups of people. However, it provides a valuable partial perspective at the macro meso and micro levels that contribute to our understanding of community-building in cMOOCs.

Keywords: **Rhizomatic Learning, connectivism, community tracking, nomadic learner behaviors, massive open online courses, MOOCs.**

INTRODUCTION

The term "MOOC" (Massive Open Online Course) was first coined by Dave Cormier (Cormier, 2008; de Waard et al., 2011) in order to describe the online course - *Connectivism & Connective Knowledge* (CCK08) facilitated by Siemens and Downes in 2008. In 2011, the term was adopted to refer to Sebastian Thrun's facilitated Artificial Intelligence (AI) MOOC which had 160,000 learners from 190 countries. These latter types of MOOCs have become known as extension Massive Open Online Course (xMOOC) while the original style of MOOC, such as CCK08, became referred to as a connectivist Massive Open Online Course (cMOOC) to differentiate their pedagogical approach from that of xMOOCs (Siemens, 2012; Guàrda, Maina & Sangrà, 2013). The MOOC phenomenon caught much attention as a disruptive innovation (Flynn, 2013; Yuan and Powell, 2013). Although both of these types of courses are called MOOCs, there are significant differences between them pedagogically. While many different categorizations and taxonomies of MOOCs have arisen since the original acronym was coined these do not fit the scope of this paper. While cMOOCs and xMOOCs are similar, in that they are open online courses that have potentially massive enrolment, they are two distinct learning models in terms of the pedagogies that they employ. xMOOCs, usually associated with established educational institutions, typically emphasize consumption of prerecorded media, while cMOOCs, often not affiliated with formal and established university courses, usually emphasize creation of media, autonomy of the learner, and a social networked learning environment (Mackness, 2013; Siemens, 2012, Koutropoulos, 2013 a/b, Glance et al, 2013). Though they have differences in terms of pedagogies, they both serve as lifelong learning opportunities to a diverse group of learners. However, the participatory nature of cMOOCs through open online learning communities is worth further investigation as this promises to provide enduring individual oriented and participatory learning opportunities.

Learners, both in physical and virtual worlds, are social beings. Vygotsky (1978) states that learners learn by socially interacting. In seeking to understand learning in online social networks we benefit from an understanding of the theoretical underpinnings of online learning communities. Within the Open and Distance Learning (ODL) perspective, the Communities of Practice (CoP) (Wenger, 1999), Community of Inquiry (CoI) (Garrison, Anderson, and Archer, 2000) and interaction types in online learning communities (Moore, 1989) are widely known as frameworks used by researchers and practitioners.

According to Wenger (1999), a social theory of learning must integrate community, identity, practice, and meaning to characterize social participation as a process of learning and knowing. CoP presents a theory of learning that starts with the assumption that engagement in social practice is the fundamental process by which we learn and in turn become who we are. In CoP, the primary unit of analysis is neither the individual nor social institutions but rather the informal *communities of practice* that people form or join as they pursue shared enterprises over time.

Garrison et al. (2000, 2001) additionally explain that, in CoI, presence is the key factor that provides deep, meaningful and active learning in an online milieu. They indicate that learning occurs within the community through the interaction of three core elements: cognitive, social, and teaching presence.

Moore (1989) further states that three types of interactions are needed in distance learning environments: learner-learner, learner-teacher, and learner-content interaction. Accordingly, interaction has a critical role as an important ingredient of online learning communities.

The above discussion indicates some of the essentials for an online learning network. Considering the theoretical necessities and the current use of online networks, it could be said that online networks have proven themselves as being a place where learning can occur, and have become a critical component of online learning in mainstream education. Presently, online networks include many diverse and global online communities, which can

act like global mega classes to those who seek knowledge as a lifelong learning endeavor (Bozkurt, 2016). Open online networks promise more than simply a network constructed by binary digits, but as a learning ecosystem that is alive.

THEORETICAL BACKGROUND

Online Learning Communities as Ecosystems

According to McLuhan (1966), all technologies are extensions of human functions. McLuhan used examples of both classical technologies and technologies of his time to demonstrate this. For example, the wheel is an extension of the foot, or similarly networks are extensions of the human neural system. Taking this into consideration it is plausible to suggest that as technologies advance they could be seen to represent extensions of more complex forms of the human experience. Hansen, Shneiderman and Smith (2010) state that online networks are formed from many physical processes and project themselves as structures within the World Wide Web. D'Andrea, Ferri and Grifoni (2010) further state that emergence network technologies and their evolution, enable people to present themselves as they do in the real world. This might suggest that open online social networks are more representative as organic ecosystems rather than synthetic structures.

Brown (1999), writing about learning, proposed that a learning ecology is "a collection of overlapping communities of interest (virtual), cross-pollinating with each other, constantly evolving, and largely self-organizing" (Brown, 1999, slide.19). Uden, Wangsa and Dmani then apply this to the digital realm, indicating that "a digital ecosystem is a self-organizing, digital infrastructure focused on creating a digital environment that supports the cooperation, knowledge sharing, and the development of open and adaptive technologies and evolutionary learning models" (Uden, Wangsa and Damiani, 2007, p.114). Richardson elaborates upon this model, noting that with digital learning ecologies, students can have "open and immediate access" to the learning materials that they need at the time that they need them, and can personalize that environment to suit their own needs. (Richardson, 2002, p.48). Supporting these ideas, Pata and Bardone (2014) claim that MOOCs are ecosystems at distributed cognition level that facilitate knowledge transformations.

As Cormier says, "[t]he idea is to think of a classroom/community/network as an ecosystem in which each individual is spreading their own understanding with the pieces...available in an ecosystem" (Cormier, 2012). The public negotiation of that acquisition is through aggregating, remixing, repurposing and feed forwarding (Downes, 2010) provides a contextual curriculum to remix back into the existing research, thoughts, and ideas in a given field.

Connectivism: A Learning Theory for the Digital Age

Connectivism, as a theory, explains how learning occurs throughout networks. Connectivism is a synthesis of Chaos, Network, Complexity and Self-Organization Theories (Siemens, 2004). It is an extension of constructivism, and is born in, and for, a digital age. The pioneers of connectivism, Siemens (2004; 2006a) and Downes (2005; 2012) claim that these traditional theories are incapable of explaining learning in digital era. Connectivism claims that "knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks" (Downes, 2012).

According to Siemens (2004) the most important aspect of learning isn't learning new content, but rather being able to "plug into sources" of knowledge and information to acquire the relevant information at the point that it is needed. In a world that continually grows and produces more knowledge, it is this access to the sources knowledge, that the learners do not currently have available to them, which are an asset to the learner, and not the memorization of current knowledge. This, in effect, positions the learner as a lifelong learner and not someone whose knowledge base will be obsolete or not applicable sometime after the knowledge is received.

The digital paradigm shift gives everyone a message that what happens in pedagogy today is a change from biological to networked digital theories which reflects characteristics of web culture, digital learners and learning (Bozkurt, 2014). Traditional theories of pedagogy have some limitations as they mainly concentrate on internal learning processes, biologically processing information in the brain, and are incapable of explaining learning with technology and how learning happens within organizations (Siemens, 2004). Connectivism focuses on where the knowledge is and how learners interact on networks, on the other hand rhizomatic learning focuses on how learners navigate and detour through the network and pursue knowledge as a creative quest for learning.

Rhizomatic Thinking

The notion of the rhizome is a metaphor for learning in the postmodern state of information sharing and knowledge building (Kjærgaard and Sorensen, 2014). Rhizomatic thinking, and by extension rhizomatic learning, is a philosophy, a heutagogical approach, a critical approach, and a combination of all these; yet most importantly it is a form of inquiry for those that excel in learning from informal experiences.

In *A Thousand Plateaus,* Deleuze and Guattari (1987) explain the difference between arborescent and rhizomatic thinking. Arborescent thinking is a model of thought which is hierarchically structured like a tree which branches out from one set of firm roots and a trunk. Rhizomatic thinking is messier and complicated, and is compared to a complex system of roots with many connections between them (Le Grange, 2007). These two types of thought are the very antithesis of each other: arborescences are "hierarchical, stratified totalities" while rhizomes are "non-hierarchical, horizontal multiplicities" (Bogue, 1989, p.107). In addition, Deleuze and Guattari identify six characteristics of the rhizome:

- **1 and 2. Principles of connection and heterogeneity: any point of a rhizome can be connected to anything other, and must be.**
- **3. Principle of multiplicity: it is only when the multiple is effectively treated as a substantive, "multiplicity," that it ceases to have any relation to the One as subject or object, natural or spiritual reality, image and world.**
- **4. Principle of asignifying rupture: against the over signifying breaks separating structures or cutting across a single structure. A rhizome may be broken, shattered at a given spot, but it will start up again on one of its old lines, or on new lines.**
- **5 and 6. Principles of cartography and decalcomania: a rhizome is not amenable to any structural or generative model. It is a stranger to any idea of genetic axis or deep structure (1987:7-12).**

Rhizomatic Learning

According to rhizomatic thinking, the problem situation—that is, the one requiring learning—is by nature a real experience that forms "an intrinsic genesis, not an extrinsic conditioning" (Deleuze, 1994, p.154). We learn nothing from those who say: 'Do as I do'. The only teachers who really help us learn are those who encourage us to take a 'do with me' approach, and are able to show us how to modify and reproduce what they do in different and diverse situations, rather than only allow us to copy them (Deleuze, 1994, p. 23, Semetsky, 2003). In rhizomatic learning, knowledge can only be negotiated in an experience that is collaborative and contextual. The metaphor of the rhizome represents a reframing of knowledge in order to deal with the unavailability of canonical knowledge and disciplines on the *bleeding-edge*, where knowledge does not exist and needs to be discovered (Cormier, 2008).

"Rhizomes grow and propagate in a *nomadic fashion*, the only restrictions to growth being those that exist in the surrounding habitat. Seen as a model for the construction of knowledge, rhizomatic processes hint at the interconnectedness of ideas as well as boundless exploration across many fronts from many different starting points" (Sharples et al., 2012, p.33). Within a learning structure, rhizomatic learning means that [nomads] are able to connect and traverse from any point to any other point according to perceived learning need (Lian, 2004). Therefore, whatever paths learners follow or whatever

destinations they reach in their rhizomatic quest are actually determined by identifying by themselves or by negotiating with other rhizomes (Lian, 2011).

Inspired by Deleuze and Guattari's rhizomatic thinking, Cormier explains rhizomatic learning as follows: "[Rhizomatic learning] takes their view of knowledge as resilient, alinear, and uncertain and applies it to the learning process" (Cormier, 2015) Cormier uses the biological metaphor of the rhizome for this view of knowledge. As a metaphor the rhizome acts as a way to understand the branching and connecting of ideas that arises in the learning process, and the fact that there can be more than one conversation happening concurrently: "[t]his participatory view of learning has the advantage of allowing multiple narratives to exist around a given theme, while constantly running the risk of being subject to the normal push and pull of power that exists in any learning community" (Cormier, 2015). "In the rhizomatic model of learning, curriculum is not driven by predefined inputs from experts; it is constructed and negotiated in real time by the contributions of those engaged in the learning process. This community acts as the curriculum, spontaneously shaping, constructing, and reconstructing itself and the subject of its learning in the same way that the rhizome responds to changing environmental conditions." (Cormier, 2008).

Nomadic Learners: The n^{th} Learners

Just as the rhizome becomes a useful metaphor for describing a theory of learning, the nomad becomes an apt metaphor for the learner. If the rhizomatic theory of learning is a metaphor for the act or theory of learning in its natural state, the nomadic metaphor embodies that theory into a person. So, how do these kinds of learners function in an ecosystem of learning? "Nomads exist only in becoming and in interaction" (Deleuze and Guattari, 1987, p.430).

The rhizomatic nomad is intrinsically motivated toward the pursuit of what some call learning or knowledge. What the nomad really is, however, just another phase of becoming. This pursuit is defined by the appropriation of authority often held over knowledge by some distant other figure by the nomad him/her/itself. This is hard to understand if knowledge is thought of as a binary concept such as right/wrong, is/is not, or proven/unproven. To the nomadic learner knowledge is not a static component to be obtained, but rather a flexible changing element to be alchemically interacted with, and the only goal of which is further pursuit.

Nomads experience freedom by being unconstrained and through constant movement. Nomadic wandering in the discursive fields of education is "not as 'losing *one's* way' but as losing *the* way – as losing any sense that just one 'way' could ever be prefixed and privileged by the definite article. Like rhizomes, nomads have no desire to follow one path" (Gough, 2005, p.13). "The space of [nomad] thought is qualitatively different from State space. Nomad space is "smooth," or open-ended. One can rise up at any point and move to any other. Its mode of distribution is the *nomos:* arraying oneself in an open space (hold the street), as opposed to the *logos* of entrenching oneself in a closed space (hold the fort)" (Deleuze and Guattari, 1987, p.xiii). In other words, informal and amorphous smooth spaces are about movement, while formal and structured striated spaces are about arrival (Bayne, 2004). For this reason, the complex and chaotic structure of the Web is a viable milieu, a smooth space for nomadic learners. Considering that cMOOCs have a nonlinear structure, they are a great learning opportunity for wandering nomads.

PURPOSE OF THE RESEARCH

Community detection is important in order to understand the global influence of networked learning communities through gates they open. It is also important to see the local influence of networked learners within the networked community because learning is a social process and learning cannot be understood only by focusing on local or global aspects. In addition, we are interested in analyzing how communities form and coalesce in order to understand how to emulate that process. With this in mind, the general purpose

of this research is to explore network dynamics in a connectivist rhizomatic learning environment with multiple perspectives.

Considering that networks are multi-layered, researchers of this article conducted the analysis within different levels to x-ray rhizo15 network from different angles and to better understand the nature of it. On this basis, community structure will be explored in macro, meso and micro levels through empirical observations of specific datasets and network visualization methods. Additionally, nomadic learner behaviors will be deciphered on distributed networks. Lastly, conversations on microblogging platform will be examined in terms of presence types of CoI.

METHODOLOGY

Research Design

In this research, a mixed method approach is employed and explanatory sequential design is used to collect, analyze and understand both quantitative and qualitative data. According to Creswell (2004), an explanatory sequential mixed methods design consists of two strands: First quantitative data is analyzed and then qualitative data is analyzed to help explain or elaborate on the quantitative results and have a better understanding. For the purposes of the research, social network analysis was employed in the first strand and content analysis is employed in the second strand.

First Strand: Social Network Analysis

As social media have emerged as a widespread platform for human interaction, the invisible ties that link each of us to others have become more visible and machine readable. As a method, social network analysis (SNA) can be used to study, track, and compare the dynamics of communities and the influence of individual contributions. SNA provides powerful ways to map, summarize and visualize networks and identify key vertices that occupy strategic locations and positions within the matrix of links (Hansen, Shneiderman and Smith, 2010).

The science of SNA claims that "our relationships, taken together, define who we are and how we act" (Tsvetovat and Kouznetsov, 2011, p.2) and on a broader view, it is the application of interpersonal relationships and connections on networks (Hansen, Shneiderman and Smith, 2010). SNA differ from other social science approaches because its focus is relationships between actors rather than the attributes of individual actors. It assumes with a holistic view that "types and patterns of relationships emerge from individual connectivity and that the presence (or absence) of such types and patterns have substantial effects on the network and its constituents" (Mika, 2007, p.27).

In SNA, networks are usually visualized in a social network diagram, where vertices are represented as points and edges are represented as lines to conceptualize and to analyze them (Bozkurt et al., 2015). Vertices are also called nodes, agents, entities, actors or items and they may represent people or social structures such as work groups, teams, organizations, institutions, states, or even countries. Edges can also be called links, ties, connections, arcs, and relationships and they may represent many different types of relationships like proximity, collaborations, kinship, friendship, trade partnerships, citations, investments, hyperlinking, transactions, and shared attributes. Visualizations that map these structures complement numerical measures to provide intuitions and insights into the shape, size, density, sub-regions, and key locations within a connected population. It offers a form of x-ray image of the organizational structure of a community in helping users to discover patterns, trends, clusters, and outliers, even in complex social networks (Hansen, Shneiderman and Smith, 2010). Within this perspective, SNA is thought to be an appropriate research methodology to seek some answers for the purpose of the research.

Second Strand: Content Analysis

Content analysis is a technique based on explicit rules of coding (Berelson, 1952) and can be used to analyze written (textual), spoken (aural) words or static (drawings, photos, charts, graphs, maps) and dynamic (video, animation) graphics. Content analysis, which uses both qualitative and quantitative approaches, is used to make inferences, interpretations, counting, summarizing or categorization of the different types of the content.

Sampling

Dave Cormier facilitated the cMOOC *Rhizomatic Learning: A Practical View* (also known as #rhizo15) for 6 weeks from April 14 to May 26 in 2015 (Cormier, 2015). This was the second iteration of a MOOC on rhizomatic learning after #rhizo14 the year before (Cormier, 2014). Facebook, Twitter and Google+ were used as the main discussion environments. Individual participant blogs were mainly used for reflection posts. Because the structure of Twitter is more convenient for hashtag tracking, Twitter was preferred as the platform for community tracking and identification in addition to deciphering #rhizo15 nomadic learner behaviors.

Network interactions started one week prior to the official start and lasted three more weeks after official end of the cMOOC. The interactions marked with the #rhizo15 hashtag continued to be used sparsely even three months after the official end. However, assuming that learners who followed this cMOOC did so through the Rhizo15 newsletters during its official running dates, a six-week Twitter interaction of rhizomatic learners was chosen as the sample of this study. The overall data visualization and metrics of the six-week time period is presented in Figure 1 and Table 1.

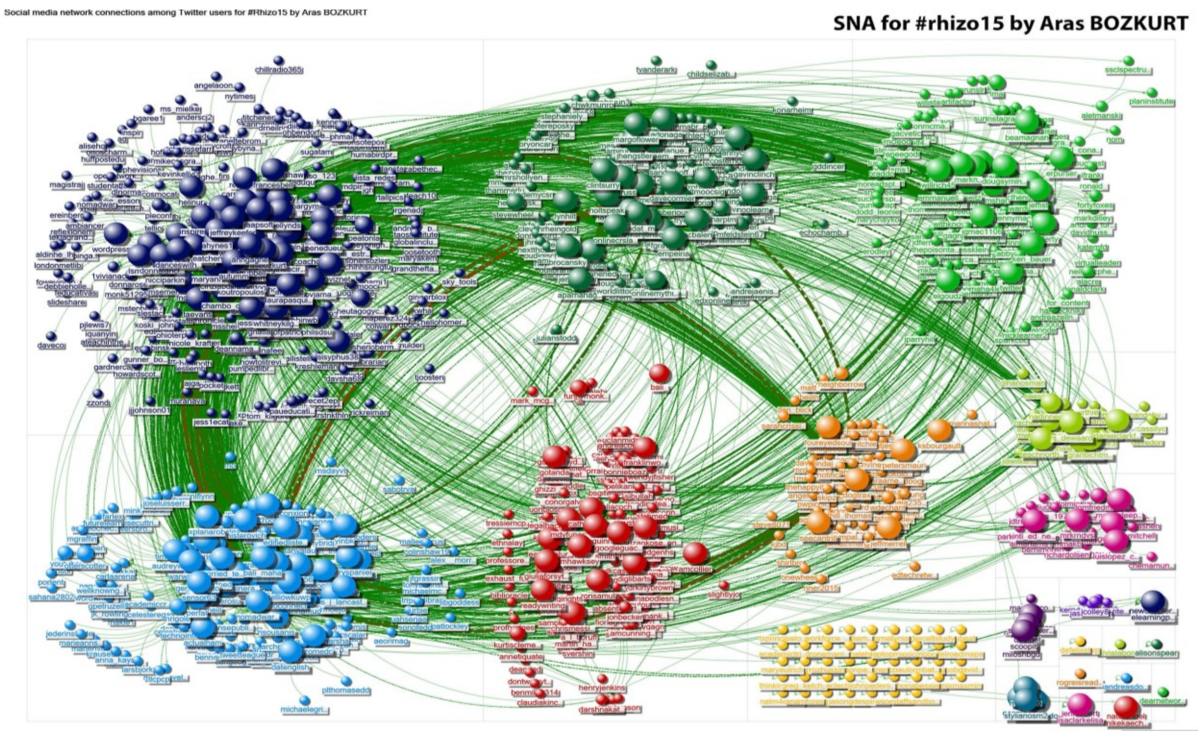


Figure 1:
The six week representation of #rhizo15 network interactions

Table: 1
The six week SNA metrics of #rhizo15

Vertices	**1121**
Unique Edges	**2979**
Edges with Duplicates	**16316**
Total Edges	**19295**
Self-Loops	**2073**
Reciprocated Vertex Pair Ratio	**0,224179994578477**
Reciprocated Edge Ratio	**0,366253321523472**
Connected Components	**51**
Single-Vertex Connected Components	**43**
Maxi. Vertices in a Connected Component	**1061**
Max. Edges in a Connected Component	**19232**
Maximum Geodesic Distance (Diameter)	**6**
Average Geodesic Distance	**2,931887**
Graph Density	**0,003596**
Modularity	**0,105431**

Data Collection and Analysis Procedure

First Strand

Twitter data was collected via NodeXL. A total of six weeks' worth of data was analyzed. As directed graphs, vertices were grouped by cluster using the Clauset-Newman-Moore cluster algorithm (Clauset, Newman and Moore, 2004; Clauset, Moore and Newman, 2008) which is more efficient than other algorithms for community detecting (Rodrigues, Milic-Frayling, Smith, Shneiderman and Hansen, 2011) Clauset-Newman-Moore cluster algorithm is a probabilistic model of hierarchical clustering for complex networks which is used to detect community structure and extract meaningful communities from the network.

The graphs were laid out using the Harel-Koren Fast Multiscale layout algorithm (Harel and Koren, 2001). Harel-Koren Fast Multiscale layout algorithm is a force directed graph drawing approach which is used to find the multi-scale representation of a graph and to devise a locally nice, aesthetic layout. In graphs, the edge colors, widths, sizes and opacities are based on edge weight values. Edge weight is considered as the strength of relationships on the graph and represents interactions in the network. The vertices are based on betweenness centrality values. Betweenness centrality can be defined as the number of shortest paths from all vertices to all others that pass through that node. Hansen et al. (2010) stress that it is an important value because it represents a kind of bridge score, a measure of how much removing a person would disrupt the connections between other people in the network.

For each graph, overall Graph Metrics were calculated including total number of the vertices, unique edges, edges with duplicates, total edges, self-loops. Additionally, reciprocated vertex pair ratio, reciprocated edge ratio, connected components, single-vertex connected components, maximum vertices in a connected component, maximum edges in a connected component, maximum geodesic distance (diameter), average geodesic distance, graph density and modularity values were reported.

The analysis represents approximately 20,000 interactions which was pulled from the six-week cMOOC #rhizo15, in which maximum participation was 431 learners (week 1) and minimum participation was 205 learners (week 6) on Twitter which represents 47,5% overall persistent engagement. In this research, the operational definition of interaction refers to Rhizomatic Learning cMOOC participants' engagements (all tweets, retweets and mentions) during their inquiry on Twitter. The data is extracted from tweets which included #rhizo15 hashtag.

The research findings were reported in macro, meso and micro levels. For the macro level, the ten most used hashtags for each week that were employed during Rhizomatic Learning cMOOC were identified and analyzed using descriptive statistics. Following that, SNA of hashtags was conducted with NodeXL in order to explore connections between members

of the Rhizomatic Learning community and to track other communities that engaged with the #rhizo15 hashtag.

At the meso level, the overall findings were analyzed week by week and the community development process was examined. Additionally, clusters (sub networks or sub communities in #rhizo15) were identified.

At the micro level we performed a sequential analysis. The rationale for a sequential analysis is that an ecosystem consists of interrelated and independent elements and these elements interact and influence one another directly or indirectly to maintain their activity and the existence of the system. In order to perform a micro level analysis, week three was chosen with the assumption that a learning ecology will be settled by this time. Following that, in the first stage, the most active cluster in week three was identified, and in the second stage this cluster was subdivided into clusters on a separate SNA, and in the third stage, the most active cluster identified in the second were divided into clusters (continued till we get the smallest meaningful cluster which took six steps) using Clauset-Newman-Moore cluster algorithm. The purpose of this analysis was to x-ray the community structure and understand community formation at a micro level in addition to analysis in macro level.

Second Strand

Twitter conversations were analyzed using qualitative analysis tool NVivo10. 3,978 lines of textual conversations from week three were examined according to categories of CoI. As categories and indicators were defined previously, rather than employing emerging coding, Twitter conversations were coded according to the categories of CoI.

Reliability

Twitter conversations in the second strand were coded by one of the authors of the article according to three types of presences of CoI. Tweets were coded with most distinct presence types observed though one single tweet may contain more than one presence types. An independent researcher recoded Twitter conversations to increase reliability. Proposed by Cohen (1960), measurement of the agreement between two raters was calculated using the Kappa statistic. Accordingly, inter-rater reliability between two raters are $\kappa = .8543$, SE = 0.0635 95%, CI = 0.7298 to 0.9788. Altman (1991) reported that 0.81 to 1.00 intervals very good. Therefore, coding in the second strand of the research can be considered as acceptable with .8543 Cohen's Kappa value.

Strengths and Limitations

This research has some limitations in addition to strengths. First of all, distributed learning environments are not limited to one single social network site. For instance, the Rhizomatic Learning cMOOC was hosted on many other platforms such as Facebook group, a web page owned by the facilitator, blog posts, and many others. However, it would be beyond the scope of this research to include all interactions, because it is currently not feasible to collect a complete corpus of data on all of the other services. The tools used to collect Twitter data have provided us with a complete corpus of tweets posted during the time period analyzed. At the moment tools to collect similar interactions for other networks, blogs, and commenting services on blogs do not provide as complete a picture as does Twitter data collections. This lack of data completeness may, in-fact, portray a skewed image of what's occurring in these networks. We have thus focused only on Twitter as a network, despite the inherent limitations. Thus, considering that our sample represents network interactions on Twitter, the following issues are also limitations of this research: Firstly, not all of the learners in this cMOOC engaged in all learning activities and some did not participate via Twitter at all. Secondly, though not many, not all the learners used #rhizo15 hashtag in their communications regarding the course. Therefore, the research findings do not include all the network activities.

This research provides findings derived from a large amount of data which is meaningful considering the diversity of networks, heterogeneity of the learner backgrounds and globally dispersed learners from different geographies and time zones. Analyzing this data

in multiple perspectives and levels poses as the first strength of the research. Secondly, it fills an important gap in MOOC literature. MOOC research has basically had two phases: cMOOC research until 2012 (Phase I) and a dominant focus to xMOOCs (Phase II) after 2012 (Ebben and Murphy, 2013). It is also stated that even though MOOCs generate a plethora of data in digital form, this volume has so far limited researchers to analyzing only a tiny portion of the available data, restricting our understanding of MOOCs (Liyanagunawardena, Adams and Williams 2013). In this sense, this research intends to improve and contribute to the existing literature by examining some of the massive volume of empirical data which is generated by a cMOOC. We believe that an exploration of a learning community structure will be helpful for future MOOC designers in terms of learning (for cMOOCs) and instructional design (for xMOOCs).

FINDINGS AND DISCUSSION

Nature of the Network Ecology

Developed by Brofenbrenner (1979), an ecological framework for human development explains human interaction in five environmental systems: Microsystem, mesosystem, exosystem, macrosystem and chronosystem. The ecological metaphor is a well suited framework to understand human interactions and learning in unstructured contexts (Jackson, 2013). Based on the same framework, yet limited to three systems, the research findings of this study are presented in three systems: Macro, meso and micro levels.

Macro Level

During the Rhizomatic learning cMOOC, the #rhizo15 hashtag was used 10,233 times. We used #rhizo15 as a core hashtag and identified other hashtags (Figure 2) that connect #rhizo15 community to other communities.

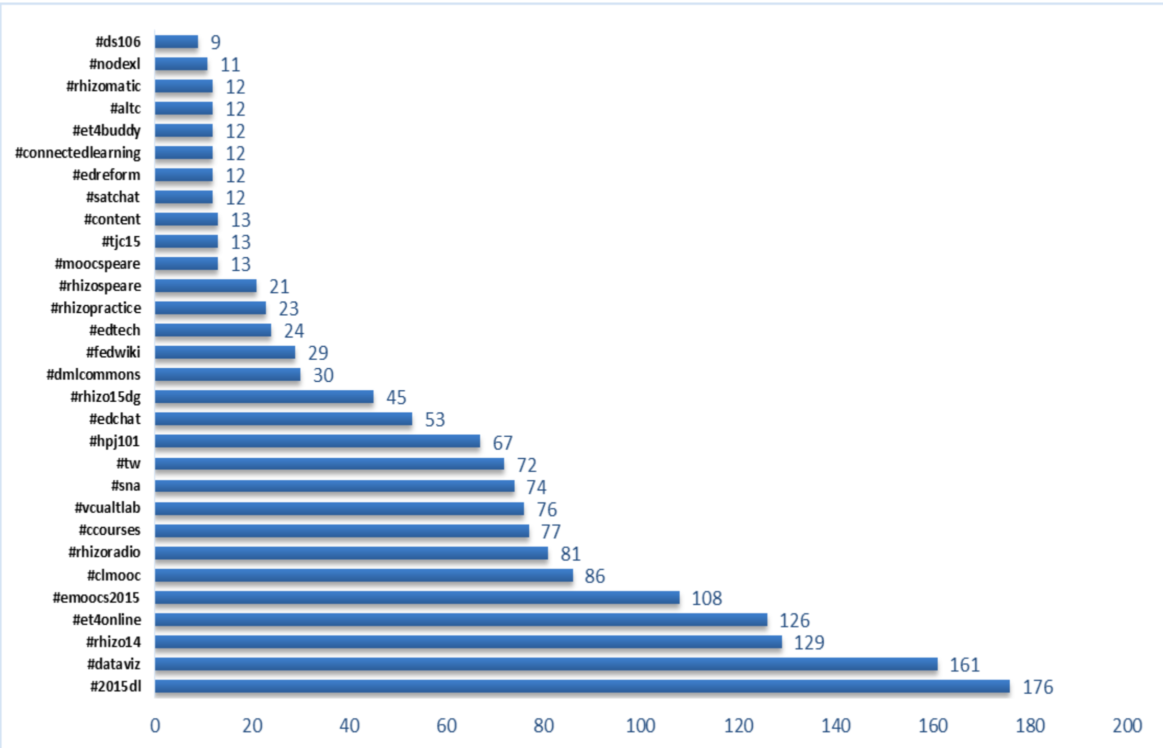


Figure: 2
Hashtags used during Rhizomatic learning cMOOC (N=1589).

To be able to further investigate, we conducted a SNA of hashtags using their frequency in edge width and node size (Figure 3.) and visualized an undirected graph.

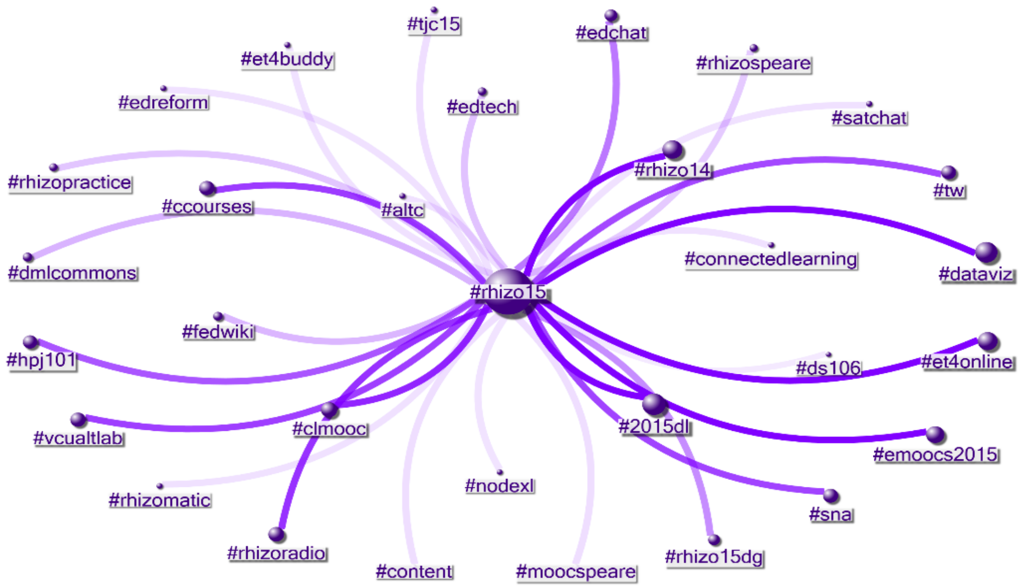


Figure: 3
Network graph of hashtags in Rhizomatic Learning cMOOC.

The analysis of hashtags reveals some interesting facts. For example, hashtags have some roles as conduits that enable information to flow between different communities. Surprisingly, communities marked with hashtags may refer to past, present or future communities. For instance, the #rhizo14 hashtag (which is the previous version of the Rhizomatic Learning MOOC) belongs to 2014. #hpj101, #emoocs2015, #et4online and #dmlcommons were simultaneously occurring events while Rhizomatic Learning cMOOC was in progress. #clmooc was a past and future event and the future version of it did not exist at the time of #rhizo15. Based on these findings, it is clear that learning communities on distributed networks do not have fixed boundaries - they even intersect or overlap without time restriction. A nomadic learner may exist in multiple communities at the same time. It is obvious that hashtags fulfill some duties in a learning community. They are used to mark a community and additionally used as a social glue to keep the learners together in a CoP. They may also be seen to exclude to set boundaries as to whom was included in a conversation or not.

In addition, this analysis also shows that hashtags, without time and space constriction, tie multiple communities like a wormhole or Einstein-Rosen Bridge which can be defined as a shortcut through space-time. Nomadic learners can get in or out of different learning communities simply by tracking a hashtag. Bozkurt (2014) explains the situation with a metaphoric example: Accordingly, nomads follow *the white rabbit* to discover *The Wonderland* in our networked globe.

It is also clear that hashtags may refer not only to online learning communities formed by learners, but also ideas, discussions and other concepts which may physically not exist. As an example, #sna refers to social network analysis, #nodexl refers to an open source SNA software and #content refers to a discussion within the community. There are some native hashtags as well. #rhizopractice, #rhizoradio, #rhizo15dg and #rhizomatic hashtags were directly connected to #rhizo15 and posed as a secondary hashtag around which subnetworks were emerged within #rhizo15 network.

The macro level analysis demonstrates that communities in a rhizomatic connectivist network have chaotic relationships with other communities in different dimensions. In summary, nomadic learners appear in different open online communities and these communities are not completely separated from each other.

Meso Level

The analysis represents six weeks of data and is purposefully separated for each week in order to observe the process (Table 2).

Table: 2
The overall metrics of Rhizomatic Learning cMOOC

Metrics	1st Week	2nd Week	3rd week	4th Week	5th Week	6th Week
Vertices	431	351	368	217	239	205
Unique Edges	1102	902	856	482	510	528
Edges with Duplicates	3741	3271	3122	1737	1767	1277
Total Edges	4843	4173	3978	2219	2277	1805
Self-Loops	483	403	419	224	298	246
Reciprocated Vertex Pair Ratio	0,226429	0,212569	0,236084	0,261324	0,220779	0,252991
Reciprocated Edge Ratio	0,369249	0,350609	0,381987	0,414364	0,361702	0,403819
Connected Components	9	18	36	18	15	8
Single-Vertex Connected Comp.	7	15	27	16	11	6
Max. Vertices in a Connected Comp.	422	332	324	199	222	195
Max. Edges in a Connected Comp.	4829	4149	3937	2202	2258	1796
Max. Geodesic Distance (Diameter)	6	7	6	6	7	6
Average Geodesic Distance	2,86565	2,962094	2,828672	2,974734	2,899548	2,879701
Graph Density	0,008913	0,010679	0,009536	0,015446	0,013220	0,017527
Modularity	0,149112	0,14168	0,143043	0,13722	0,150137	0,164116

The data in Table 1 demonstrates some dynamics and their effects in an open online learning community. There is an 18.5% decrease in the numbers of learners (vertices) in the second week. The first week seems to be a landing area in which Nomadic learners decide to settle in the community for a while or to wander on the networks to meet their learning needs. It can be further interpreted that the first week is a natural selection period in an open online ecology and what is left is dedicated nomadic learners. Within a heuristic perspective, it should be also noted that some learners joined in #rhizo15 experience in different weeks rather than the first week of the cMOOC and similarly these weeks are served in a similar manner. Koutropoulos et al. (2012) explains that learners can dip-in or jump-out anytime of the MOOC according to their learning needs which can be also related to type of MOOC learners. Hill (2013) identifies four types of learners: Lurker, active participants, passive participants and drop-ins. These learners can be categorized as drop-ins who are partially or fully active for their specific learning needs.

Secondly, the changing interaction pattern of the network is salient. Graph density is the metric between 0 and 1 indicating how interconnected the vertices are in the network. It is the ratio of the observed number of ties divided by the maximum possible ties. In other words, it is indicator of the total interaction within the network. When compared, there is an inverse ratio between the number of total learners and graph density measure. In MOOC literature, dropout rates have been a phenomenon and MOOCs are generally criticized because of high dropout rates. However, in contrast to what might be thought, as the number of the learners decrease, interaction increases. The graph density of the network increased gradually from 0.008913 to 0.017527 which can be interpreted as high because it is twice as high as the first week. We can further infer that smaller group formations, fluidity in those groups and less Transactional Distance reasoned with high graph density value.

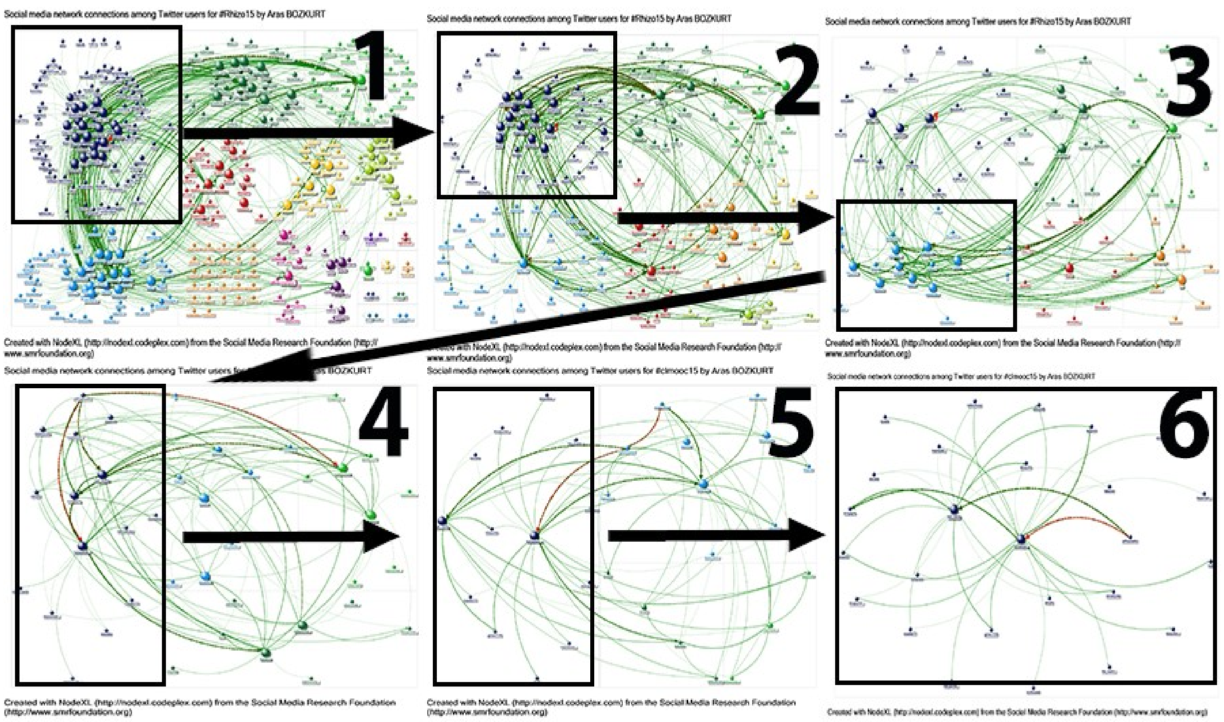
In terms of community structure, metrics regarding connected components reveal some facts about the structure of the learning network. As mentioned previously, the pattern changes after first week which may be assumed to be an orientation week. According the SNA conducted before official opening, there were interactions on Twitter network which demonstrated an inward facing hubs and spoke, broadcast network pattern. This pattern can be result of promoting and orientation efforts for #rhizo15. In direct proportion to the decrease in the number of the learners, the number of connected components and single vertex connected components (isolated nodes/lurkers) decrease. However, reciprocated edge ratio (mutual interaction) increases.

According to the Milgram Experiment (Milgram, 1967), the six degrees, or steps, mean that even in large networks where most people are not directly connected, people can be reached from every other person through a small number of steps (Hansen, Shneiderman and Smith, 2010). In the #rhizo15 sample, the average geodesic distance changes from minimum 2.828672 (third week) to maximum 2.974734 (fourth week) which means that number of the steps to engage with other learners is ideal to form a community because it requires more steps in a physical world.

Micro Level

In order to bring to the surface the hidden pattern of a cluster, we selected the week three SNA and sampled the most connected cluster. In a similar manner to examining under the microscope, we grouped the vertices by using the Clauset-Newman-Moore cluster algorithm. We repeated the same process until we observed the smallest meaningful pattern (Table 3).

Table: 3
Clustering week 3 SNA data into sub networks.



	1st cluster	2nd cluster	3rd cluster	4th cluster	5th cluster	6th cluster
Vertices	368	182	90	40	30	26
Unique Edges	856	353	171	66	37	17
Edges with Duplicates	3122	2167	1591	1110	862	501
Total Edges	3978	2520	1762	1176	899	518
Self-Loops	419	188	99	4	0	0
Reciprocated Vertex Pair Ratio	0,23608	0,34570	0,44525	0,54074	0,62650	0,725
Reciprocated Edge Ratio	0,38198	0,51378	0,61616	0,70192	0,77037	0,84057
Connected Components	36	1	1	1	1	1
Single-Vertex Connected Comp.	27	0	0	0	0	0
Max. Vertices in a Connected Comp.	324	182	90	40	30	26
Max. Edges in a Connected Comp.	3937	2520	1762	1176	899	518
Max. Geodesic Distance (Diameter)	6	5	4	4	3	3
Average Geodesic Distance	2,828672	2,562251	2,32963	2,0875	1,86	1,828402
Graph Density	0,009536	0,020915	0,049438	0,133333	0,155172	0,106153
Modularity	0,143043	0,101955	0,072287	0,05047	0,043975	0,071257

This analysis demonstrates that after first cluster (3rd week's data), the maximum geodesic value (from 6 to 3) and the average geodesic distance (from 2.828672 to 1.828402) decreases. This data further demonstrates that the nature of open online ecosystems is very convenient to form a community, it is even easier than physical world. This may be result of eliminating time and space constraints that exist in real world settings. Similarly, the graph density metric, which is directly relevant to interactivity, increases and peaks in fifth cluster. Though these results are natural after isolating one cluster from the network, it also indicates actual metrics regarding the learning community.

In terms of identifying nomadic learner behavior, the 6th cluster surface that learners start forming a community like a swarm. Some learners with high influence (who were nicknamed "Queen Bee" during #rhizo15) set the climate; facilitated, amplified and disseminated a single idea beyond the learners and networks. This behavior of learners also indicates the importance of curation in a connectivist rhizomatic learning network in order to form a tightly connected, highly interactive community.

Nature of the Learning Conversations

The Twitter conversation in week three is examined in terms of three types of presences of CoI in order to understand nature of the Twitter conversations. Elements of CoI (Garrison, Anderson and Archer 2000; Garrison, Anderson and Archer, 2001) are used as themes and categories are used as codes in content analysis. CoI coding template is given in Table 4.

Table: 4
Coding template of CoI (Ice et al, 2007)

Elements	Categories	Indicators (examples only)
Social Presence	Open Communication Group Cohesion Personal/Affective	Learning climate/risk-free expression Group identity/collaboration Self-Projection/Expressing emotions
Cognitive Presence	Triggering Event Exploration Integration Resolution	Sense of puzzlement Information exchange Connecting ideas Apply new ideas
Teaching Presence	Design & Organization Facilitating Discourse Direct Instruction	Setting curriculum & methods Shaping constructive Exchange Focusing and resolving issues

The analysis included 3,978 tweets, replies, and retweets from week three. Only tweets and replies were coded in data set. The results of the content analysis of week three are shown in Table 5. According to indicators of CoI, cognitive presence (80%), social presence (19%) and teaching presence (1%) were observed on Twitter chats.

Table: 5
Results of content analysis

Elements Categories	Percentage	Number of Coding References
Cognitive Presence	80%	1231
• Triggering Event • Exploration • Integration • Resolution	• 13% • 76% • 7% • 4%	• 161 • 934 • 82 • 54
Social Presence	19%	289
• Open Communication • Group Cohesion • Personal/Affective	• 11% • 17% • 72%	• 31 • 50 • 208
Teaching Presence	1%	19
• Design & Organization • Facilitating Discourse • Direct Instruction	• 47% • 19% • 37%	• 9 • 3 • 7

Cognitive Presence

Cognitive presence was the most frequently appearing category in our analysis of week 3 tweets tagged #rhizo15. This analysis revealed that Twitter conversations often started with a thought provoking triggering event that resulted in a chain reaction of progress toward the exploration, integration and resolution phases. Triggering events pushed learners to think, question, and clarify with one another. Through this process individual thoughts were transformed into collective discoveries. In the integration and resolution phases, nomads often expanded their understanding of triggering events further by stepping outside of Twitter. In these phases, external artifacts (e.g. blog posts, collaborative writing projects, digital art, and music) were often shared via Twitter with a URL and are thus included in the analysis. This allowed nomads to expand their learning explorations past the 140-character limit on Twitter. A salient point being that nomads exhibit higher order learning skills by analyzing, evaluating and creating collaboratively.

For example, most of the conversations start with triggering events as the first tweet in Appendix 2 shows. Triggering event tweets, may contain only one or more triggering events or, after synthesizing information, the results can lead to another triggering event. In the Twitter conversation in Appendix 2, all of the phases of cognitive presence can be seen. One simple tweet transforms into an inquiry and end up with evaluation, synthesizing and creation of the knowledge. The conversation and phases of cognitive presence are a linear and interpenetrating. Each tweet has its own discourse and different audiences.

Story of a Conversation on Twitter

One person tweets the facilitator asking when the new prompt would be posted. They use the hashtag #rhizo15. Another person sees the tweet and affirms they are waiting impatiently, too. The facilitator reminds these two people that they are on a European time zone while he is on North America time. A conversation ensues where more than 6 other participants chime in about the impact of time zones on learning in a MOOC, whether it skews content, or makes the MOOC more energetic, and how it feels to wake up to find many tweets from a conversation others had while you were asleep. The conversation splits into different threads involving different people, and includes comparing synchronous and asynchronous communication and philosophical musings about conversations that span time and space. It ends with one of the participants posting a comic rendition of the conversation (a light-hearted way to view the conversation). This all takes place in the space of X number of tweets over Y number of minutes/hours and involves a total of Z participants. What started out as an inquiry, spreads to some light-hearted banter, then some philosophical discussion, and some inferences about what it means to be learning and interacting online, and ends with some more light-hearted banter (The original Twitter conversation is given in Appendix 2).

This analysis also reveals some important findings that are not related to CoI. Firstly, linking external sources creates multiple layers on distributed learning environments. In other words, links tie different learning ecologies to each other which are used for exchange and reflection of ideas. Secondly, retweets serve not only to spread the words, but also to address a wider audience in learning ecology. Thus, the open structure of learning ecology poses as an important factor as different nomads can in and out to these conversations. Finally, this analysis also reveals an important finding: One of the essential point in connectivist learning ecologies are thought provoking questions that learners can pursue.

Social Presence

Social presence is the second most observed presence types. Indicators of open communication and group cohesion indicators were fewer when compared to personal/affective category. Indicators of personal/affective category mostly observed through emotional words or emoticons (Table 6). Though not included into analysis, many participants shared visuals that reflect their emotional presence which is defined as emotionally being there (Cleveland-Innes and Campbell, 2012).

Table: 6
Sample Twitter conversations for social presence (personal/affective)

- @dougsymington 👣👣👣 #rhizo15 footsteps plus 🐾 dog tracks
- @NBCavillones oh my, what an awful image :O #rhizo15
- @sensor63 @Autumm @dogtrax @NBCavillones @inspirepassion @willrich45 electronic dance music, u know ur soundtrack to everything ;) #rhizo15

Intimacy (Argyle and Dean, 1965) and immediacy (Wiener and Mehrabian, 1968) are two important factors that increase social presence in an open online learning environment. Intimacy usually observed in personal affective category, however it seems that immediacy is provided by learners from different time zones of the globe. As it was discussed in a Twitter chat (Appendix 2), learners provided 24/7 discussions. It is also worth mentioning that even though pace and flow of the discussions were constant, it was asynchronous in synchronous discussions in many cases for the learners that belong to the different time zones.

Teaching Presence

Teaching presence was the least observed presence type which could be a result of the autonomous, self-regulated, self-directed learners in this distributed learning network. Facilitating discourse and direct instruction indicators were vague and mostly provided by other learners rather than the facilitator of the cMOOC. The design and organization category was the most observed category within teaching presence (Table 7). These examples of teaching presence indicators were often not predefined by design of the cMOOC but rather were a kind of guiding from more experienced nomads to novice nomads explaining aspects of the course. There is a radical shift in teacher-student roles in cMOOCs. These empirical findings confirm Siemens' (2006b, p.42) statement that "the learner is the teacher is the learner".

Table: 7
Sample Twitter conversations for teaching presence (design and organization)

- hey @Bali_Maha Shall I jump into #rhizo15 from #week1 or just skip first 2 or #anyOfTheAbove?
- @ken_bauer @Bali_Maha You used the hashtag ... you're in already .. welcome #rhizo15
- @ken_bauer @Bali_Maha Join in, look, lurk, read to your heart's content! So much to dig through and new thoughts to think! Enjoying #rhizo15

CONCLUSION AND FUTURE IMPLICATIONS

This study examines a connectivist rhizomatic learning environment within multiple perspectives and reveals research findings regarding cMOOCs, community formation, nomadic learners in a rhizomatic learning setting. Additionally, this research explains both rhizomatic thinking and rhizomatic learning through a literature review.

Macro level analysis reveals that hashtags link multiple past, present and future learning communities and serve as conduit for information flow among these communities. Nomadic learners use hashtags to traverse among these communities and additionally hashtags also function as a social glue to keep learners and learning communities. Meso level analysis surfaces that decrease in number of learners (dropout rates) increases interaction among the learners. Thus, dropouts in a cMOOC or drop-in learner types is part of evaluation process for community formation and interestingly affect learning process positively in some aspects. Micro level analysis demonstrates that open online ecosystems are relatively convenient environments to form a learning community in a global scale because it eliminates time and space constraints that exist in real world settings. Additionally, it is found that some learners have critical roles as they enrich learning experiences and pose like a rhizome which interacts with other rhizomes in a quest of learning according to their subjectives.

Examination of a conversation on twitter through lenses of presences from CoI led to an understanding that cognitive presence has a critical function for meaningful learning experiences and it is most observed presence type (80%) in connectivist rhizomatic learning environment. Social presence (19%) is the second most observed presence type with emotional words or emoticons. Teaching presence (1%), not surprisingly, is the least observed presence type which is quite natural for self-directed learners.

All things considered, it can be concluded that the chaotic, uncertain and distributed nature of open online networks as ecosystems embrace rhizomatic learning practices and nomadic learners. Based on the findings that reveals high cognitive presence, higher order learning skills and low dropout/high completion rate when compared to other MOOCs, it can be further concluded that rhizomatic learning and connectivist learning theory greatly match and complete each other, and promise a lot for online networked, distributed learning experiences.

Based on the research findings revealed in this study, the following future implications can be taken into consideration:

- **This research focused on distributed learning environments on a cMOOC and examined connectivist learning ecology within different perspectives by employing both qualitative and quantitative approaches. Considering that MOOCs are an increasing trend in online learning, similar research that focus on xMOOCs can contribute to literature a lot.**
- **As a research methodology, authors of this study used a mixed research design employing SNA and content analysis. However, studies that employ qualitative approaches to explore participants' views such as ethnography or phenomenology would be very beneficial to better understand both connectivist and extended MOOC phenomena.**
- **Social network sites (SNSs) may vary and they are not all the same. This research used a microblogging site to collect and analyze data. However, there**

is a need to examine other SNSs' potential for MOOC learners and rhizomatic learning opportunities.

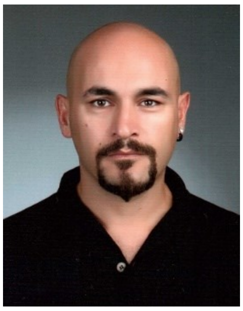
- Both c and x MOOCs are globally distributed learning environments in time and place. Even a synchronous learning environment can transform into an asynchronous learning environment because of the limitations in time and space. It seems that globally connected learners from different time zones and geographies will be available in future. As it was explored in a Twitter chat in Appendix 2, this case can be further examined to investigate, understand and thus to design learning environments for those globally distributed learners.

Ethical Considerations: The data was collected from public domain of microblogging platform Twitter. The user names are explicitly used because it is publicly available open data that does not constitute human subjects research. This type of data is exempt from Institutional Review Board (IRB) clearance or permission. However, those whose names are appeared in Appendix 2 were informed about topic, purpose and authors of the research as a matter of courtesy.

Authors' Notes: 1. Cormier reported that 'D&G hate the word metaphor… I have certain feelings about how the word translates into English. It's the reason I use the word story [instead of other terms such as pedagogy, theory, framework or approach].' (Bali & Honeychurch, 2014).

2. Deleuze and Guattari used some words specially to explain rhizomatic thinking with a philosophic lens. They purposefully preferred to play with words. Besides, they used some words in capitals in the middle of the sentences. To stick to the original philosophic ideas, the authors have generally used direct citations from Deleuze and Guattari and kept paraphrased expressions regarding rhizomatic thinking to a minimum.

BIODATA and CONTACT ADDRESSES of the AUTHORS



Aras BOZKURT received his MA and PhD degrees in Distance Education from Anadolu University. He serves as a reviewer for several journals in distance education field and he is also an editorial board member of eLearn Magazine. His current research interests are topics related to digital books, interactive e-books, gamification, game-based learning, research trends in distance education, social networks, online interaction, online learning spaces, online learning communities, online community formation and online learning. He is also interested in critical theories such as connectivism, rhizomatic learning, heutagogy and emerging research paradigms such as social network analysis, sentiment analysis, and data mining.

Aras BOZKURT, Ph.D.
Ministry of Education, Eskisehir, 26100, Turkey
Phone: +905058544404
e-Mail: arasbozkurt@gmail.com

Sarah HONEYCHURCH is a Learning Technology Specialist and Philosophy TA at the University of Glasgow in Scotland. She has a BA and MA in Philosophy from the University of Southampton and is currently studying for a PhD in Education at the University of Glasgow looking at how online peer interactions can stimulate learning. Her blog is http://www.nomadwarmachine.co.uk

Sarah HONEYCHURCH
University of Glasgow, Learning and Teaching Centre
Southpark House, 64 Southpark Avenue, Glasgow G12 8LB, Scotland
Phone: +44 141 330 3026
e-Mail: Sarah.Honeychurch@glasgow.ac.uk

Autumm CAINES is the Associate Director of Academic Technology at Capital University in Columbus Ohio. Autumm earned her MA in Educational Technology from The Ohio State University, her BS in Communication Technology from Eastern Michigan University, and an AA in Liberal Arts as well as a certificate in Web Design from Oakland Community College. In fall of 2016 she will start teaching a first year seminar on digital citizenship at Capital University. She also serves as a Co-Director at Virtuallyconnecting.org

Autumm CAINES
Associate Director of Academic Technology
Capital University, Center for Excellence in Learning and Teaching
1 College and Main, Columbus OH 43209
Phone: +1614-236-6633
e-Mail: acaines@capital.edu

Maha BALI is Associate Professor of Practice, Center for Learning and Teaching, American University in Cairo. Editor at Hybrid Pedagogy and editorial board member of Journal of Pedagogic Development. Co-founder of Virtuallyconnecting.org and Edcontexts.org

Maha BALI
American University in Cairo, Center for Learning and Teaching,
113 Kasr El Aini St., P.O. Box 2511 Cairo, 11511, Egypt
Phone: +20226153613
e-Mail: bali@aucegypt.edu

Apostolos KOUTROPOULOS is the program manager for the online MA program in Applied Linguistics at the University of Massachusetts Boston. He is also an adjunct faculty member of the Instructional Design MEd program. Over the last few years he has participated in many massive online open courses (MOOCs) and has co-authored research papers with colleagues around the globe. AK holds a BA in computer science, an MBA with a focus on human resources, an MSc in information technology, an MEd in instructional design, and an MA in applied linguistics. He is currently an EdD student at Athabasca University. His research interests include online learning, knowledge management, educational technology, linguistics, and games in education.

Apostolos KOUTROPOULOS
UMass Boston, Applied Linguistics Department
100 Morrissey Boulevard, Boston, MA, 02125, The USA
Phone: +16172875990
e-Mail: a.koutropoulos@umb.edu

Dave CORMIER is an educational researcher and speaker on Open Learning, MOOCs and the impact of technology on the future of education. At the University of Prince Edward Island he has lead student retention, academic planning, domestic recruitment, first year advisement and is currently leading New Student Orientation and Web Communications.

Dave CORMIER
University of Prince Edward Island, 550 University Avenue,
Charlottetown Prince Edward Island, Canada C1A 4P3
Phone: 1902 566 0908
e-Mail: davcormier@upei.ca

REFERENCES

Altman, D. G. (1990). *Practical statistics for medical research.* CRC press.

Argyle, M., & Dean, J. (1965). Eye contact and distance affiliation. *Sociometry, 28*(3), 289-304.

Bali, M. & Honeychurch, S. (2014). Key Pedagogic Thinkers—Dave Cormier. *Journal of Pedagogic Development, 4*(3). Retrieved from http://www.beds.ac.uk/jpd/volume-4-issue-3/key-pedagogicthinkers-maha-bali

Bayne, S. (2004). Smoothness and striation in digital learning spaces. *E-Learning and Digital Media, 1*(2), 302-316.

Berelson, B. (1952). *Content analysis in communication research.* Glencoe, Ill: Free Press.

Bogue, R. (1989). *Deleuze and Guattari*. London: Routledge.

Bozkurt, A. (2014). Renaissance 2.0: Connecting Dots. In Proceedings of *The Association for Educational Communications and Technology (AECT) 2014 International Convention*, (pp. 221-228). Jacksonville, FL, USA.

Bozkurt, A. (2016). *Identifying Interaction Patterns and Teacher-Learner Roles in Connectivist Massive Open Online Courses.* Doctoral dissertation. Anadolu University, Graduate School of Social Sciences, Distance Education Department, Eskisehir, Turkey.

Bozkurt, A., Akgun-Ozbek, E., Yilmazel, S., Erdogdu, E., Ucar, H., Guler, E., Sezgin, S., Karadeniz, A., Sen-Ersoy, N., Goksel-Canbek, N., Dincer, G., Ari, S., & Aydin, C. H. (2015). Trends in distance education research: A content analysis of journals 2009-2013. *The International Review of Research in Open and Distributed Learning, 16*(1), 330-363.

Bronfenbrenner, U. (1979). *The Ecology of Human Development: Experiments by Nature and Design*. Cambridge, MA: Harvard University Press.

Brown, J. S. (1999). Learning, Working & Playing in the Digital Age. In *AAHE 1999 conference on Higher Education.* Washington, DC. Retrieved from http://www.internettime.com/jsb.pdf

Clauset, A., Moore, C., & Newman, M. E. (2008). Hierarchical structure and the prediction of missing links in networks. *Nature*, *453*(7191), 98-101.

Clauset, A., Newman, M. E., & Moore, C. (2004). Finding community structure in very large networks. *Physical review E*, *70*(6), 066111.

Cleveland-Innes, M., & Campbell, P. (2012). Emotional presence, learning, and the online learning environment. *The International Review of Research in Open and Distance Learning, 13*(4), 269-292.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and psychological measurement, 20*(1), 37-46.

Cormier, D. (2008). Rhizomatic education: Community as curriculum. *Innovate: Journal of Online Education*, *4*(5), 2. http://davecormier.com/edblog/2008/06/03/rhizomatic-education-community-as-curriculum/

Cormier, D. (2008). The CCK08 MOOC – Connectivism course, 1/4 way. Retrieved from http://davecormier.com/edblog/2008/10/02/the-cck08-mooc-connectivism-course-14-way/

Cormier, D. (2012). Trying to write rhizomatic learning in 300 words. Retrieved from: http://davecormier.com/edblog/2012/12/13/trying-to-write-rhizomatic-learning-in-300-words/

Cormier, D. (2014). Rhizo14–The MOOC that community built. *INNOQUAL-International Journal for Innovation and Quality in Learning*, *2*(3).

Cormier, D. (2015). What was #rhizo15. The Association for Learning Technology (ALT) *Newsletter.* https://newsletter.alt.ac.uk/2015/07/what-was-rhizome15/

Creswell, J. W. (2004). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research.* Pearson.

D'Andrea, A., Ferri, F., & Grifoni, P. (2010). An overview of methods for virtual social network analysis. In A. Ajith, A. Hassanien, & V. Snasel (Eds.), *Computational social network analysis: Trends, tools and research advances* (pp. 3–25). London, UK: Springer.

de Waard, I., Abajian, S., Gallagher, M., Hogue, R., Keskin, N., Koutropoulos, A., & Rodriguez, O. (2011). Using mLearning and MOOCs to understand chaos, emergence, and complexity in education. *The International Review of Research in Open and Distributed Learning, 12*(7), 94-115.

Deleuze, G. & Guattari, F. (1987). A Thousand Plateaus: Capitalism and Schizophrenia. *Trans. Brian Massumi.* Minneapolis: University of Minnesota Press.

Deleuze, G. & Guattari, F. (1987) *A Thousand Plateaus.* Athlone Press. London.

Deleuze, G. (1994). *Difference and Repetition*, trans. P. Patton. New York, Columbia University Press. digital practice.

Downes, S. (2005). An introduction to connective knowledge. Retrieved from http://www.downes.ca/cgi-bin/page.cgi?post=33034

Downes, S. (2010). How This Course Works. Retrieved from http://connect.downes.ca/how.htm

Downes, S. (2012). Connectivism and connective knowledge: Essays on meaning and learning networks. Retrieved from http://www.downes.ca/files/books/Connective_Knowledge-19May2012.pdf

Ebben, M., & Murphy, J. S. (2014). Unpacking MOOC scholarly discourse: a review of nascent MOOC scholarship. *Learning, Media and Technology*, *39*(3), 328-345.

Flynn, J. (2013). MOOCS: Disruptive innovation and the future of higher education. *Christian Education Journal*, *10*(1), 149-162.

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*, 1–19.

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of distance education, 15*(1), 7-23.

Glance, D. G., Forsey, M., & Riley, M. (2013). The pedagogical foundations of massive open online courses. *First Monday, 18*(5).

Gough, N. (2005). Geophilosophy and methodology: Science education research in a rhizomatic space. *Methodologies for researching mathematics, science and technological education in societies in transition*.

Gough, N. (2006). Shaking the tree, making a rhizome: Towards a nomadic geophilosophy of science education. *Educational Philosophy and Theory*, *38*(5), 625-645.

Guàrdia, L., Maina, M., & Sangrà, A. "MOOC design principles. A pedagogical approach from the learner's perspective." *Opening up education through innovation / eLearning*. European Commission's Directorate-General for Education and Culture, 9 May 2013. Web. Retrieved from: http://www.openeducationeuropa.eu/en/ article/MOOC-Design-Principles.-A-Pedagogical-Approach-from-the-Learner%E2%80%99s-Perspective

Hansen, D., Shneiderman, B., & Smith, M. A. (2010). *Analyzing social media networks with NodeXL: Insights from a connected world.* Morgan Kaufmann.

Harel, D., & Koren, Y. (2001). A Fast Multi-Scale Method for Drawing Large Graphs. In *Graph Drawing: 8th International Symposium, GD 2000, Colonial Williamsburg, VA, USA, September 20-23, 2000, Proceedings* (No. 1984, p. 183). Springer Science & Business Media.

Hill, P. (2013).The Four Student Archetypes Emerging in MOOCs. http://mfeldstein.com/the-four-student-archetypes-emerging-in-moocs/

Ice, P., Arbaugh, B., Diaz, S., Garrison, D. R., Richardson, J. Shea, P., & Swan, K. (2007). Community of Inquiry Framework: Validation and Instrument Development. *The 13th Annual Sloan-C International Conference on Online Learning*, Orlando. Retrieved from http://cde.athabascau.ca/coi_site/presentations/Sloan_CoI_Orlando_07.pdf

Jackson, N. J. (2013) The Concept of Learning Ecologies. in N Jackson and G B Cooper (Eds). *Lifewide Learning, Education and Personal Development E-Book*. Chapter A5 available on-line at: http://www.lifewideebook.co.uk/.

Kjærgaard, T., & Sorensen, E. K. (2014, June). Rhizomatic, digital habitat-A study of connected learning and technology application. In *Proceedings of the 9th International Conference on e-Learning: ICEL 2014* (p. 221). Academic Conferences Limited. https://www.researchgate.net/publication/262945019_Rhizomatic_digital_habitat_A_study_of_connected_learning_and_technology_application

Koutropoulos, A. (2013b) MOOCs in Higher Education: Options, Affordances, Pitfalls (Part 2). *Learning Solutions Magazine.* 2013, July 22. Retrieved from http://www.learningsolutionsmag.com/articles/1205/moocs-in-higher-education-options-affordances-pitfalls-part-1

Koutropoulos, A. (2013a) MOOCs in Higher Education: Options, Affordances, Pitfalls (Part 1). *Learning Solutions Magazine.* 2013, July 15. Retrieved from http://www.learningsolutionsmag.com/articles/1211/moocs-in-higher-education-options-affordances-and-pitfalls-part-2

Koutropoulos, A., Gallagher, M. S., Abajian, S. C., de Waard, I., Hogue, R. J., Keskin, N. O., & Rodriguez, C. O. (2012). Emotive Vocabulary in MOOCs: Context & Participant Retention. *European Journal of Open, Distance and E-Learning*. Retrieved from http://www.eurodl.org/?p=archives&year=2012&halfyear=1&article=507

Le Grange, L. (2007). The 'theoretical foundations' of community service-learning: from taproots to rhizomes. *Education as Change*, *11*(3), 3-13.

Lian, A. P. (2011). Reflections on language-learning in the 21st century: The rhizome at work. *Rangsit Journal of Arts and Sciences*, *1*(1), 5-17.

Lian, A-P. (2004). Technology-enhanced language-learning environments. In J-B. Son (Ed.): *Computer-Assisted Language Learning: Concepts, Contexts and Practices* (pp. 1-20), New York: iUniverse.

Liyanagunawardena, T., Adams, A., & Williams, S. (2013). MOOCs: A systematic study of the published literature 2008-2012. *The International Review of Research in Open and Distributed Learning, 14*(3), 202-227.

McLuhan, Marshall (1966/1964). *Understanding Media: The Extensions of Man.* New York: McGraw-Hill. Paperback edition, 1966.

Mika, P. (2007). *Social networks and the semantic web.* Springer.

Milgram, S. (1967). The small world problem. *Psychology today, 2*(1), 60-67.

Moore, M. (1989). Three types of interaction. *American Journal of Distance Education, 3*(2), 1-6.

Pata, K., & Bardone, E. (2014). Promoting Distributed Cognition at MOOC Ecosystems. In *Learning and Collaboration Technologies. Designing and Developing Novel Learning Experiences* (pp. 204-215). Springer International Publishing.

Richardson, A. (2002). An ecology of learning and the role of elearning in the learning environment. *Global Summit of Online Knowledge Networks,* 47-51.Retrieved fromhttp://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan007791.pdf

Rodrigues, E. M., Milic-Frayling, N., Smith, M., Shneiderman, B., & Hansen, D. (2011, October). Group-in-a-Box layout for multi-faceted analysis of communities. In *Privacy, Security, Risk and Trust (PASSAT) and 2011 IEEE Third Inernational Conference on Social Computing (SocialCom), 2011 IEEE Third International Conference on* (pp. 354-361). IEEE.

Semetsky, I. (2003). Deleuze's new image of thought, or Dewey revisited. *Educational Philosophy and Theory, 35*(1), 17-29.

Sharples, M., McAndrew, P., Weller, M., Ferguson, R., FitzGerald, E., Hirst, T., Mor, Y., Gaved, M. and Whitelock, D. (2012). *Innovating Pedagogy 2012: Open University Innovation Report 1.* Milton Keynes: The Open University*.*

Siemens, G. (2003). Learning Ecology, Communities, and Networks Extending the classroom. Retrieved from http://www.elearnspace.org/Articles/learning_communities.htm

Siemens, G. (2004). Connectivism: A learning theory for the digital age. Retrieved from http://www.elearnspace.org/Articles/connectivism.htm

Siemens, G. (2006a). Connectivism: Learning theory or pastime for the self-amused? Retrieved from http://www.elearnspace.org/Articles/connectivism_self-amused.htm

Siemens, G. (2006b). *Knowing knowledge.* Vancouver, BC, Canada: Lulu Press.

Siemens, G. (2012, July 25). MOOCS are really a platform. Retrieved from http://www.elearnspace.org/blog/2012/07/25/moocs-are-really-a-platform/

Swan, K., Garrison, D. R. & Richardson, J. C. (2009). A constructivist approach to online learning: the Community of Inquiry framework. In Payne, C. R. (Ed.) *Information Technology and Constructivismin Higher Education: Progressive Learning Frameworks* (43-57). Hershey, PA: IGI Global.

Tillmanns, T., Holland, C., Lorenzi, F. and McDonagh, P. (2014) Interplay of rhizome and education for sustainable development. *Journal of Teacher Education for Sustainability, 16*(2), 5-17.

Tsvetovat, M., & Kouznetsov, A. (2011). *Social Network Analysis for Startups.* O'Reilly Media, Inc.

Uden, L., Wangsa, I. T., & Damiani, E. (2007). The future of E-learning: E-learning ecosystem. In *Digital EcoSystems and Technologies Conference, 2007: DEST'07*. Inaugural IEEE-IES (pp. 113-117). IEEE. Retrieved from http://www.fcet.staffs.ac.uk/itw1/lorna_ince.pdf

Vygotsky, L. S. (1978). *Mind in society, the development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wenger, E. (1999). Communities of practice: Learning, meaning, and identity. Cambridge university press.

Wiener, M., & Mehrabian, A. (1968). L*anguage within language: Immediacy, a channel in verbal communication.* New York: Appleton-Century-Crofts.

Yuan, L., & Powell, S. (2013). *MOOCs and open education: Implications for higher education.* Cetis White Paper. Retrieved from http://publications.cetis.ac.uk/wp-content/uploads/2013/03/MOOCs-and-Open-Education.pdf

APPENDIXES

Appendix: 1
Definitions of SNA terms

- **Vertices (nodes, agents, entities, actors or items): They can represent individuals or social structures.**
- **Edges (links, ties, connections, arcs, or relationships): They can represent any form of relationship or connection that occurs through exchange or interaction between two vertices.**
- **Degree/Degree centrality: Total number of unique edges (in and out) that are connected to a vertex. When the graph is directed, degree metrics can be indegree (points inward) or outdegree (points outward).**
- **Betweenness Centrality: It is a score that indicates a node's ability to bridge different subnetworks in a network. In other words, it is a measure of a node's centrality in the network which is equal to the number of shortest paths from all other vertices to all others that pass through that node.**
- **Closeness Centrality: It is a distance score that is calculated by capturing the average shortest distance between a vertex and every other vertex in the network.**
- **Eigenvector centrality: It is a metric that indicates influence score for strategically connected vertices which takes into consideration not only how many connections a vertex has, but also the degree of the vertices that it is connected to. Similarly, The PageRank algorithm is a variant of eigenvector centrality.**
- **Graph density: It is a metric that measures the sum of edges divided by the total number of possible edges and demonstrates the level of interconnectedness of the vertices. The number from 0 to 1 indicates how interconnected the vertices in a network.**
- **Component: Communities, subnetworks, groups, or clusters in a single network.**
- **Geodesic Distance (Diameter): It is the length of the shortest path between vertices.**
- **Modularity: It is a metric for measuring the structure of a graph. It is used to measure the strength of division of a network into modules.**

Appendix: 2
Sample Twitter conversations for cognitive presence

- @davecormier What do we have on #rhizo15 menu? I am hungry 4 learning ;) That's wednesday night... Give an apple 2 eat in networked paradise
- Yes, @davecormier we are waiting for #rhizo15 week 3
- @NomadWarMachine @arasbozkurt kids go to bed at 830. It ll be after that :)
- @davecormier @NomadWarMachine It is 01:15 am in my time zone :) It is thursday now... See the massiveness in time and place #rhizo15
- @davecormier @NomadWarMachine Gonna catch #rhizo15 3rd week staff 2morrow... Maybe I can catch u all in my rhizomatic dream ;)
- @arasbozkurt @davecormier @NomadWarMachine See ya on the flip side of your night (which will be flip side of my day?) #rhizo15 timezones
- @dogtrax @arasbozkurt @davecormier @NomadWarMachine yes someone should blog on how time zones skew content in #rhizo15
- @dogtrax @davecormier @NomadWarMachine Agreed @AnnGagne, it is important to keep the pace and flow of the MOOC #rhizo15
    - @arasbozkurt @dogtrax @davecormier @NomadWarMachine @AnnGagne Re: #rhizo15 pace/flow: why is it important?
        - @VCVaile @dogtrax @davecormier @NomadWarMachine @AnnGagne to increase the social interaction...
        - @arasbozkurt @dogtrax @davecormier @NomadWarMachine @AnnGagne but growing naturally esp if #rhizo15 is not only flow under cultivation
        - @AnnGagne @arasbozkurt @dogtrax @davecormier @NomadWarMachine so #rhizo15 is like an all night diner? Less the hours than the frenetic pace
        - @VCVaile @AnnGagne @arasbozkurt @dogtrax @davecormier Good analogy for #rhizo15
    - @VCVaile @arasbozkurt @dogtrax @davecormier @NomadWarMachine it keeps engagement/idea expansion high #rhizo15
    - @AnnGagne @VCVaile @arasbozkurt @dogtrax @davecormier @NomadWarMachine These timezone issues make #rhizo15 energetic, as we are always here.
    - @JeffreyKeefer @AnnGagne @VCVaile @dogtrax @davecormier @NomadWarMachine #rhizo15 MOOC is 7/24 interactive wit branches all around the world
    - @VCVaile @arasbozkurt @dogtrax @davecormier @NomadWarMachine think one could argue that #rhizo15 timezone span makes it more comprehensive
    - @AnnGagne @VCVaile @arasbozkurt @dogtrax @davecormier It's nice to wake up and catch up with the overnight conversation in #rhizo15
- @dogtrax @davecormier @NomadWarMachine @AnnGagne time zones are a big obstacle 4 sync discussions... #rhizo15
        - @arasbozkurt @dogtrax @davecormier @NomadWarMachine @AnnGagne Though synchrnous Tweet threads ebb and flow across #rhizo15
        - @JeffreyKeefer @arasbozkurt @dogtrax @davecormier @NomadWarMachine @AnnGagne still conversations if we chime in when we catch up? #rhizo15
            - @lisahubbell @arasbozkurt @dogtrax @davecormier @NomadWarMachine @AnnGagne Agreed; conversations can span space, so why not time? #rhizo15
            - @JeffreyKeefer @lisahubbell @arasbozkurt @dogtrax @davecormier @AnnGagne Agreed #rhizo15 allows for asynch
            - @lisahubbell @JeffreyKeefer @arasbozkurt @dogtrax @davecormier @NomadWarMachine definitely! #rhizo15 time is anytime- also allows to reflect
- @dogtrax @davecormier @NomadWarMachine @AnnGagne I see the that there two major groups: MOOCers from America and Europe #rhizo15
    - @arasbozkurt @dogtrax @davecormier @AnnGagne Interesting to see the viz about that #rhizo15
    - @dogtrax @davecormier @AnnGagne I was thinking about that @NomadWarMachine #rhizo15
- @dogtrax @davecormier @NomadWarMachine @AnnGagne That's why, the group discussions are going on day and night ;) #rhizo15
- @arasbozkurt @davecormier @NomadWarMachine @AnnGagne Time is elusive ... A #rhizo15 comic pic.twitter.com/x5JytFTe7Q
    - @dogtrax @arasbozkurt @davecormier @NomadWarMachine this is amazing, Kevin!

Time zones of #rhizo15 MOOCers. 3 distinct groups from all around the globe.... [visual attached in original tweet]