# The Role of Connectors in Supporting Knowledge Construction in xMOOC Learning Networks: A Mixed Methods Case Study

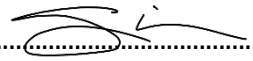
Sean William John McMinn BA (Hons), MA, MET

September 2020

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

Department of Educational Research, Lancaster University, UK.

This thesis results entirely from my own work and has not been offered previously for any other degree or diploma. The word-length of this thesis is 53,582 words.

Signature  .....

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## Abstract

Massive Open Online Courses (MOOCs) are a relatively new phenomenon in the field of online education. The literature has both praised the potential for xMOOCs, highly structured courses that centre around a series of short video lectures, automated marking, and peer evaluation, enhancing learning outcomes and condemned them for not being innovative at all, with some suggesting that xMOOCs reinforce a teacher-centred approach to teaching and learning.

Empirical research on xMOOCs is still relatively new, ranging from the subject of attrition rates, communication patterns, , and learning analytics. Yet, there is still little empirical evidence showing how learning occurs in xMOOCs. More specifically, it's not understood how participants engage in collaborative dialogue and knowledge construction. Furthermore, the literature is lacking in describing how or who influences the sequence of knowledge construction in xMOOCs. Recent research suggests that a social network analysis approach to MOOC research may provide insight on how participants engage with each other, and whether some are more influential than others in how knowledge is shared, understood or constructed.

This thesis adopts a mixed methods case study design using (1) social network analysis, and (2) Interaction Analysis Model (IAM) to explore how xMOOC participants with high

centrality measures support knowledge construction. The results show that SNA of xMOOC discussion forums can identify participants who are in the position to be connectors, highly influential in a social network; however, IAM of the discussion forums suggest that they play a minimal role in the sequence of knowledge construction among participants. This suggests connectors are not influential in an xMOOC learning network, despite the power of their position. The implications of these findings informs both researchers of how engagement and knowledge construction does not happen automatically, and that instructor or instructional design intervention may be needed.

Key words: MOOCs, cMOOCs, xMOOCs, Knowledge Construction, Connectors, Social Network Analysis, learning networks.

# Ackowledgements

This thesis was made possible thanks to the support of numerous people over the past few years. This includes all of my loved ones in Canada and Hong Kong. The constant support from friends and family helped make this possible. In addition to my general expression of gratitude, I would like to express special ackowledgements to the following people.

I would like to thank my supervisor, Dr. Murat Oztok, whose patience for me is more than I deserve. Your encouragement, guidance and helpful comments enabled me to see this through and produce something I am proud of.

I am also greatly indebted to colleagues at the Hong Kong University of Science and Technology. In particular, I am thankful to Nick Noakes, whose friendship and mentorship has been more influencial than he probably knows. I am also thankful for all of the support I received from Dr. Arthur McNeil, Dr. Keith Tong, and Dr. Melinda Whong.

To my Mom and Dad, thank you for being who you are – the perfect parents. To my brother Jamie and my sister Kim, thank you for always believing in me; I am lucky to have you both in my life. And thanks finally, to Tina, who has been more forgiving than I deserve and has shown me that perseverance reaps rewards.

# List of Abbreviations

| | |
|---|---|
| CoI | Community of Inquiry |
| CoP | Community of Practice |
| CSCL | Computer Supportive Collaborative Learning |
| IAM | Interaction Analysis Model |
| KC | Knowledge Construction |
| MOOC | Massive Open Online Course |
| cMOOC | Connectivist Massive Open Online Course |
| xMOOC | Structered Massive Open Online Course |
| SNA | Social Network Analysis |

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# Chapter 1: Introduction

This chapter identifies a research problem of identifying whether xMOOC participants, particularly those who are central within the learning network, engage in knowledge construction in the discussion forums and explains an approach in which the problem can be addressed. The chapter begins by providing historical background on MOOCs and an overview of MOOC research. This is followed by a brief description of the researcher's professional background to contextualize the study. The following sections then explain the purpose of this research study and identifies the research questions and research approach. A brief overview of networked learning is also described to provide the context of the research. The chapter concludes by explaining the impact of this study and the limitations and weakness of the research.

## 1.1 MOOCs in the context of this thesis

Massive Open Online Courses (MOOCs) are relatively new in higher education; yet, many are already speculating that they are having a widespread impact on institutions worldwide, despite their close relation to other forms of distance education (Kaplan and Haenlein, 2016). Since 2012, which was declared year of the MOOC, education researchers, academic bloggers, and news media have been keeping a close eye on the development of them (Bates, 2012; Bates, 2014; DeSantis, 2012; Kovanovic et al. 2015; Lewin, 2013; Pappano, 2012; Watters, 2012). Since then, there has been a growing list of empirical studies of MOOCs, ranging from the subject of attrition rates (Coffrin et al. 2014), design

(Maina et al., 2013), communication patterns (Gillani and Eynon, 2014a) user behaviour (Brinton et al., 2013), use of social tools (Alario-Hoyos, Muoz-Merino, Perez-Sanagustin, Delgado Kloos, and Parada, 2016), learning analytics (Alario-Hoyos et al., 2016; Tseng et al., 2016) and other research issues. Social network analysis (SNA) and visualization of data of MOOC participants' engagement has recently gained interest from MOOC researchers. For example, some are interested in the frequency and density of participant engagement in discussion forums and how that may correlate to students' final grades.

Theoretical backgrounds and concepts, such as Connectivism (Milligan et al., 2013) and social network analysis (Sinha, 2014a; Sinha, 2014b), have shed some light on how MOOC participants engage or connect with content and each other in learning networks. However, there still seems to be a lack in understanding how participants position themselves within possible learning networks and interact, or connect, with others to share, evaluate, or create knowledge in a MOOC. This is important because understanding how participants position themselves provides insight on how individuals and their connections through computer-mediated-communication contribute to the emergence of knowledge creation, transfer or understanding. Literature on MOOCs does discuss the roles or actions of participants (Clow, 2013; Koutropoulos and Gallagher, 2012; Murray, 2014) with some proposing the terms active participant, lurker, and passive participant (Milligan et al., 2013). However, these categories are vague or meaningless, often missing key elements that could explain how people connect in a MOOC. More importantly, they cannot explain what learning means in MOOCs. Does lurking imply that no learning has occurred? What is the purpose, for example, of identifying participants as lurkers? Current literature does not

provide much insight on whether learning occurs when MOOC participants connect (or not) to each other. Adding to this, it is not clear what the level or quality of a connection among MOOC participants is. These issues raise a few questions: such as, how are participants connecting in MOOC discussion forums? What social relationships exist? Are some participants who connect in discussion forums more influential than others in how knowledge is understood or constructed? Are the connections "good" enough for learning to occur?

Review of literature (McAuley et al., 2010; Storme et al., 2016; Zhu et al., 2018) indicates that there are two main categories of MOOCs to consider: xMOOCs and cMOOCs. xMOOCs are highly structured courses that centre around a series of short video lectures, automated marking, and peer evaluation. cMOOCs, are based on Connectivism, where participants build and navigate their own learning experience by choosing their own web connections (Siemens, 2006). Coursera, EdX, and Udacity courses are examples of xMOOCs. Since the emergence of cMOOCs and xMOOCs, the MOOC phenomenon grew to include a variety of designs, such as hybrid MOOCs (hMOOC), sMOOCs (small open online courses), BOOCs (big open online courses), and SPOCs (small private online courses) (Storme et al. 2016). As Storme et al. (2016) and Zhu et al. (2018) suggest, the emergence of different MOOC models, plus the increase in the number of xMOOC courses being offered by universities, is the result of a motivation to explore how MOOCs impact higher education. Storme et al. (2016) also draw attention to the problem that many educators and researchers give a "broad brush description" of MOOCs, often suggesting cMOOCs are pedagogically "good" and xMOOCs are pedagogically "bad" in design. However, it can be argued that xMOOCs and

cMOOCs share similar elements of participants' engagement, such as large cohorts enrolled in a course communicating through a discussion forum to fulfil a learning task or to create new knowledge about a topic. Storme et al. (2016) add that essentialism, "that technology has an independent educational value and that we only have to use the technology in order to realize this value" (p. 316), and instrumentalism, that "technology is a neutral means that has to be used according to the goals that are predetermined by the user" (p. 316), limits researchers' perceptions of possible MOOCs' pedagogic value or possibilities. What should be asked is what is made possible *with* and *by* MOOCs (Storme et al. 2016). Data collected for this study comes from EdX courses and falls under the category xMOOC. This is aligned with the notion that MOOC research has mainly focused on participants' behaviours and / or the impact of xMOOCs on higher education (Zhu et al. 2018). However, the limitations of focusing on a definition of xMOOCs is considered, since "MOOC-pedagogy is not embedded in MOOC-platforms, but is negotiated and emergent" (Storme et al. 2016, p. 318).

### 1.2 MOOC participants as connectors in a social network

Some scholars suggest that technology makes it possible for connected communities to form; yet, social engagement does not equate to scholarly engagement (Garrison, 2015). In the case of this study, it is the xMOOC discussion forums that make connected communities of learners possible; however, it is not clear whether participants' engagement, the connections or social ties that they make in them equate to scholarly engagement. Garrison (2015) suggests that social media in general is built upon weak ties, tenuous relationship,

among participants, which, as a result, reinforces the risk of confirmation bias because they are a leaderless organizational system, not particularly good at directing and focusing on discussion and challenging assumptions. In this sense, xMOOC discussion forums, with the potential for involving thousands of enrolled students, are similar in that participants engaged in discussion forum activity will most likely have weak ties to each other. In contrast, strong ties, "interpersonal bonds and personal goals, could limit communication and weaken cohesive group behaviour" (Garrison, 2015, p. 73). Considering this, the relations and connections among participants can have an effect on both quality and quantity of knowledge construction and sharing (Chiu, Hsu, and Wang, 2006; Oztok, Zingaro, and Makos, 2013). Additionally, meaning-making and collaboration may be inhibited in online forums due to participants' knowledge of others' social and knowledge background and the social ties they have, whether strong or weak (Oztok et al., 2013). The problem with MOOCs, as suggested by Garrison, is that participants may not take the opportunity to engage in critical discourse and contribute to thinking and learning because they do not feel strong connection, loyalty or responsibility to other members of the network.

> In a technologically connected society, the community dimension is defined by the identity of the participants in the group, not the physical location. That is, participants identify with why they are members of the group – the purpose for the group's existence. It is a place to connect with others who possess similar interests and goals. In short, community displays the characteristics of common purpose, interdependence, collaboration, and trust (Garrison, 2015, p. 54).

Analysing social networks and the social ties among leaners is one approach researchers are using to study learner engagement (Borgatti, Everett, and Johnson, 2013; Dawson, 2008; Gee and Hayes, 2011). This approach shows promising outcomes because it allows researchers to identify learners that may have an impact on a learning network, but there is still much to be studied in this area. With cMOOCs, some researchers argue that learning occurs not just through social interactions, but also through interaction with and between network nodes (people, media, places), because knowledge is distributed across a network of connections (Wang et al. 2017). Wang et al. (2014) note:

> Interactions extend from individuals to groups and networks, from closed to open, from small groups to massive possibilities. This affords opportunities for network development, potential to develop both strong and weak links, and opportunity to jump across or cross boundaries (p. 125).

Considering this, then, xMOOCs can be defined as a network; albeit, they may be a contained network. And, while there is much to learn about how learning occurs in such large, contained networks, there is a growing body of literature that focuses on the subject. For example, researchers are exploring the relationship between a student's position in a classroom social network and their reported level of sense of community, developing visualization tools to help evaluate why MOOC participants use discussion forums, developing ways for predicting course grades in a MOOC based on forum contributions, and describing how interaction analysis of online discussion can be supplemented by employing SNA (Dawson, 2008; Fu, Zhao, Cui, and Qu, 2017; Gunawardena, Flor, Gómez, and Sánchez, 2016; Wise and Cui, 2018a, 2018b; Wu, Yao, Duan, Fan, and Qu, 2016).

In particular, there are emerging studies that may be of interest to researchers which are concerned with MOOC student engagement and learning outcomes. Some of these studies analyse how social ties in a learning network have an impact on knowledge transfer. For example, Dawson's (2008) research shows that students who are well positioned in a network, and what he calls high levels of centrality, closeness and high betweenness, are often "gatekeepers" or "brokers" and influence the flow of information and resources in the network. Betweenness refers to actors in a social network that "control or mediate the relations between pairs of actors that are not directly connected" (Carolan, 2014, p. 157). This is similar to what Gladwell defines as "connectors" and "mavens" in his book, The Tipping Point (2000).

Gladwell's definition of "connectors" and "mavens" sometimes become blurred and are often the same thing within a virtual network (Nichani and Hung, 2002). For the purpose of this study, the definitions provided by Nichani and Hung (2002, p. 53) will be used:

> **Connectors:** These are people who know lots of other people. They have the extraordinary knack of making friends and acquaintances. These are people who always remember to send you a birthday card, and who will follow up even after a brief meeting. They occupy several social circles, and "their ability to span many different worlds is a function of something intrinsic to their personality, some combination of curiosity, self-confidence, sociability, and energy.
>
> **Mavens**: These are people who connect other people with information. They are information specialists, or ''information stewards." These people are obsessed not

only with collecting information, but also with wanting to tell other people about it- "The fact that Mavens want to help, for no other reason than because they like to help, turns out to be an awfully effective way of getting someone's attention".

From this point forward, the term ‘connectors’ will be used, only. So far, there is little, if any, research on weak and strong ties, or connectors in xMOOCs.

Connectors as learner types have pedagogical importance because their relations and connections among xMOOC participants can provide insight on the quality and quantity of knowledge construction and sharing. Knowledge creation in an educational context is a collaborative process (Garrison, 2011). And potentially rich network structures that can emerge in xMOOCs as a result of participants’ engagement with each other allow for collaborative knowledge creation to occur (Goodyear, 2014). In other words, the connected experiences of participants can impact knowledge creation and sharing. For example, knowledge construction may be impaired when participants are marginalized or, conversely, rely on a focused core of members (Oztok et al., 2013; Wenger, 1998). Gaining insight on connectors, who create weak ties among participants and potentially bridge knowledge sharing, in an xMOOC can inform course designers of ways knowledge creation and sharing can potentially occur, in both quality and quantity. This could lead to pedagogical designs, for example, that reduce the number of marginalized participants, or bridge communication across clusters of participants who would not otherwise connect.

## 1.3 My personal and professional background in the context of this study

Since September 2012, I have been involved in the development and use of massive open online courses (MOOC) at various levels (departmental and university-wide) at The Hong Kong University of Science and Technology (HKUST). During this period, the university has partnered with two major MOOC providers, Coursera and edX, for delivering courses through online platforms. HKUST's main mission involves gaining a better understanding of online learning, developing materials to be used for blended-learning, and providing innovative course design for undergraduate students, which is similar to reasons identified by Storme et al. (2016) and Zhu et al. (2018). A recent trend within the university is to investigate the use of MOOCs for the development of Small Private Online Courses (SPOCs) to be used locally for on-campus students. The university is calling this an "extended flipped" approach to learning. Within my department, the Centre for Language Education (CLE), I have been heavily involved in designing and delivering MOOCs on both the edX and Coursera platforms. The university feels that its experiences with MOOCs can provide faculty with meaningful knowledge, informing them on how to develop and deliver effective online and blended-learning courses. Additionally, clickstream data has been used as a source for understanding student engagement in HKUST MOOCs. For example, HKUST is currently developing VisMOOC, a visualization tool for clickstream data to show how MOOC participants engage content (Shi, Fu, Chen, and Qu, 2014). While this initiative is useful for understanding participants' patterns of engagement in a MOOC, there is a danger of missing key social elements related to how and why connections among participants are made. More importantly, perhaps, is that researchers have yet to explore MOOCs as social

complex systems where knowledge construction and sharing are emergent phenomena that occur through participants connecting and interacting. Considering this, the relations and connections among participants can have an effect on both quality and quantity of knowledge construction and sharing (Chiu et al., 2006; Oztok et al., 2013).

## 1.4 Research problem

The intent of this study is to learn about how connectors engage in xMOOC discussion forums, whether some are more influential than others in how knowledge is shared, understood or constructed, and whether the connections are "good" enough for learning to occur. Learning, of course, is difficult to observe because it is difficult to define; there are different strands or manifestations of learning, for example. For the purpose of this study, the concept of learning is narrowed down to knowledge construction, which is a measurable and observable manifestation of learning that can occur in xMOOC discussion forum threads. This is important because there is yet to be any method for identifying connectors and explaining how they impact the quality and quantity of knowledge construction and sharing as an emergent phenomenon in xMOOCs. How is knowledge construction, a form of learning, influenced by xMOOC connectors? Literature on connectors (Granovetter, 1973; Kotowski and dos Santos, 2010; Williams, 2006) and understanding relationships between strong and weak ties in networked environments (Jones, Ferreday, and Hodgson, 2008; Ryberg and Larsen, 2008) may allude to some answers; however, the nature of connectors in this literature is limited because they do not

consider online networked environments and cannot be applied to xMOOCs. This also has yet to be explored in xMOOC literature.

The concept of 'connectors' can be described as those who find ways to connect to others to share and collect knowledge (Gladwell, 2000). Of course, the degree of how much a person connects to others can vary. Still, the concept of a connector can help establish an understanding of how, whether, or why people connect to others in an xMOOC learning network. And, somewhat similar to Gee's (2005) theory of affinity spaces, which see "newbies" and "experts" working together in a network to learn something new, an xMOOC can have a varying degree of expertise among its participants (Breslow et al., 2013). Concepts related to the relations of weak or strong ties among connectors can inform xMOOC designers by anticipating possible participant behaviour or roles and identify possible reasons for their connections. The degree of a participant's connections (i.e. strong and weak ties) and the quality or type of knowledge sharing as a result of those connections may vary depending on various characteristics, such as a connector's expertise, preferences or patterns of engagement.

To explain student engagement and connectedness in MOOCs, some studies do provide possible categories for participants, but they are often either too vague or do not adequately show how participants position themselves in the learning network. Milligan et al. (2013) provide one of the first studies related to patterns of engagement in Connectivist MOOCs; their research suggests that MOOCs consist of three categories of participants: (1) active participants (2) lurkers and (3) passive participants. They suggest that certain

factors affect engagement, which are confidence, prior experience, and motivation. However, it is not clear how one measures motivation for engagement or whether there is enough evidence to suggest a relationship between motivation and engagement. Additionally, passive participants are not clearly defined, having been mainly described as based participants who expressed frustration with the Connectivist design of the course. In contrast, Koutropoulos and Gallagher (2012) provide their own categories: (1) lurking participants (2) moderately active participants (one or two topics are engaged), and (3) memorable active participants (participated in 5 more activities). Again, they provide only vague descriptions, and their study doesn't measure connectivity and positioning of participants within the MOOC. Kumpulainen and Saadatmand (2014) note that learners can create their own learning experiences, alone or in networks and suggest that lurkers may be peripheral learners setting their own pace within a course.

Ho et al., (2014) provide categories of registrants: (1) only registered, (2) only viewed, (3) only explored, and (4) certified. Their study shows a correlation to categories of registrants and course completion. Hill (2013) provides another set of categories to explain student patterns in an xMOOC: (1) no shows, (2) observers, (3) drop-ins, (4) passive participants, and (5) active participants. Their study indicates that the number of students in each category decreases as the course progresses. Ramesh, Goldwasser, Huang, Daume, and Getoor (2014) note two different forms of student engagement: (1) passive and (2) active. They also note another category of registrant, the auditor. In their study of two MOOCs developed at the University of Melbourne, Principles of Macroeconomics and Discrete Optimization, Coffrin et al. (2014) provide three categories: (1) auditors, (2), active, and (3)

qualified. They define qualified as the students who obtained marks above the 60th percentile in the first two weeks of the courses. Kizilcec and Piech (2013) provide these categories in their study: (1) auditing (2) completing (3) disengaging, and (4) sampling. These studies appear to be more concerned with attrition rates or score results and not connectivity or participant engagement.

Gillani and Eynon, (2014a) note communication patterns in MOOCs; however, their major findings do not provide any categories for participant engagement and only indicate that students start off with high-volume participation in on-line discussions, and over time, these conversations tailed off. Fini (2009) suggests that participants tend to be selective in choosing their learning tools and mainly prefer the most common social networks. Campbell and Gibbs (2014) distinguishes the difference between live-MOOCs and archive-MOOCs, and, consequentially, live-learners and archive-learners. Understanding how participants communicate and the frequency of communication in a MOOC can assist with identifying connectors. Yet, current studies about communication patterns in MOOCs don't refer to connectivity in ways that assist with understanding participants as connectors sharing and collecting knowledge.

Most importantly, however, is that Goodyear (2014) notes how xMOOCs are generally designed in a way that encourages unidirectional connections from the lecturer to the students, with little opportunity for students to engage in other connections. Of course, this does not mean other connections cannot occur within an xMOOC. Goodyear (2014, p. 42) goes on to say, "It is too early to say, with any confidence, but on current readings, the

xMOOC design lacks logic unless it is a course, yet the vast majority of the users of an xMOOC do not treat it as a course". A review of literature suggests research has yet to address this point. While there has been discussion across disciplines about the role and type of connectors, there does not seem to be any current research about how individuals might position themselves within an xMOOC, or any MOOC. This gap in literature suggests a need for further research to help identify connectors, their role or type, beyond that of lurker, active, and passive participant. The lack of reference to 'connectors' in literature suggests there is a need for further research on how participants position themselves in a MOOC and what type of interactions and connections participants initiate within its learning network.

Literature suggests that there are various elements involved that enable or constrain connectivity among participants in a learning network. For example, Kumpulainen and Saadatmand (2013) note the phenomena of social serendipity, which is something that some participants in an open online course may experience as a result of being connected in a learning network. However, Kop (2012, p. 3) suggests that power relations could limit connections and 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". Hodgson, McConnell, and Dirckinck-Holmfeld (2012) approach the subject from a sociological-perspective, and suggest that networked learning is achieved through participation in communities of learners where meaning is both negotiated and created through collaborative dialogue. These studies touch on elements related to how participants' engagement and connectivity

impact a learning network, each in a different way; however, they do not explore the concept of the connector, limiting any understanding of how a participant plays a role in the connectivity of a MOOC learning network.

Drawing from other disciplines and social network theories (Granovetter, 1973; Kotowski and dos Santos, 2010; Williams, 2006), literature suggests that a social network consists of various types of connectors. For example, one possible type includes people who have weak ties to others, providing new knowledge and bridging people to "form and maintain close acquaintances with others from different groups within a larger social network" (Granovetter, 1973; Kotowski and dos Santos, 2010). This is similar to discussions about weak and strong ties and networked identities and relationships in networked environments (Jones et al., 2008; Ryberg and Larsen, 2008). Williams (2006) suggests that bridging occurs "when individuals from different backgrounds make connections between social networks. These individuals often have only tentative relationships, but what they lack in depth they make up for in breadth". Another relational tie would be "bonding", which occurs when strongly tied individuals provide support for one another; people who initiate bonding among strong ties could be another type of connector. This is somewhat related to what Sinha (2014a) refers to with the Bow Tie Network Analysis. Although Sinha's (2014b) research refers to MOOC participants as two distinct groups, answer persons and discussion persons, these concepts can assist with understanding knowledge transfers in a MOOC:

> The answer person's network is primarily sparse, star-shaped, and has numerous inward connections from relative isolates […] discussion persons are those who

> contribute initial turns that elicit brief replies or who typically reply to threads initiated by others with large numbers of additional messages. The discussion person's network has dense ties to highly connected alters (p. 7).

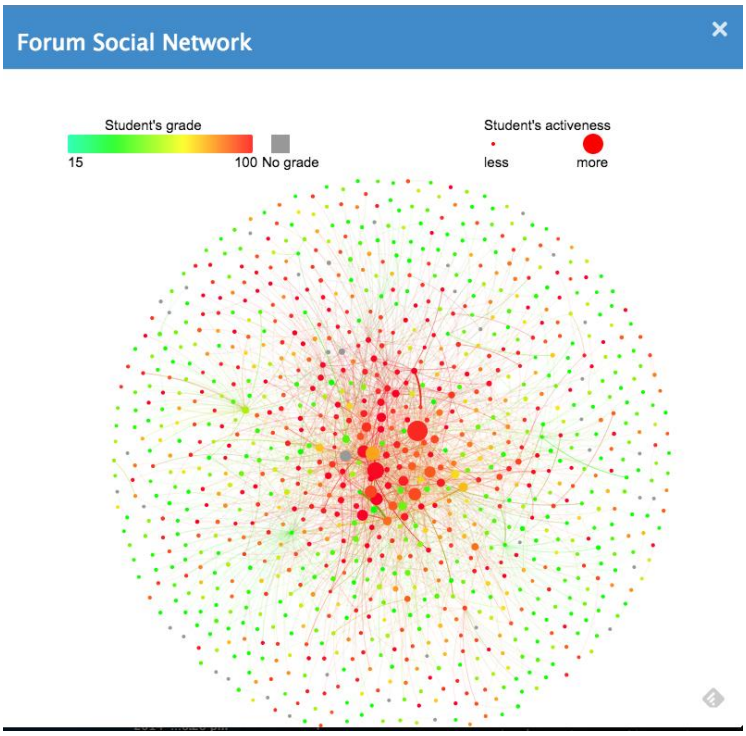
Additionally, Sedereviciute and Valentini (2011) provide other possible types of connectors in their Stakeholder Salience Model (SSM): (1) unconcerned lurkers, individuals who have no connections with other members in the network, nor do they express an interest in particular organization using social media tools – these can also be called non stakeholders, (2) unconcerned influencers, those who have connections within an examined network; however, do not express an interest in a particular organization – also called dormant stakeholders, (3) concerned lurkers, those who express an interest in an organization; however they do not have a central position in the network to exploit their messages fast on to others – also called dependent stakeholders, and (4) concerned influencers, those who have great position in the network and great interaction in an organization; they are important stakeholders since they share content – also defined as definitive stakeholders. This literature on networked learning and connectors helps frame both the review of MOOC literature and the analysis of a MOOC and participants' interactions in its learning network.

There does seem to be a growing trend in using clickstream data as a method for understanding student engagement in MOOCs. For example, HKUST is currently developing VisMOOC, a visualization tool for clickstream data to show how MOOC participants engage content (Shi et al., 2014). While this initiative is useful for understanding participants' patterns of engagement in a MOOC, there is a danger of missing key social elements related

to how and why connections among participants are made. For example, *Figure 1* shows how participants interact with each other in the discussion forum of a course.

**Figure 1**

*Visualization of whole social network from xMOOC discussion forum data*

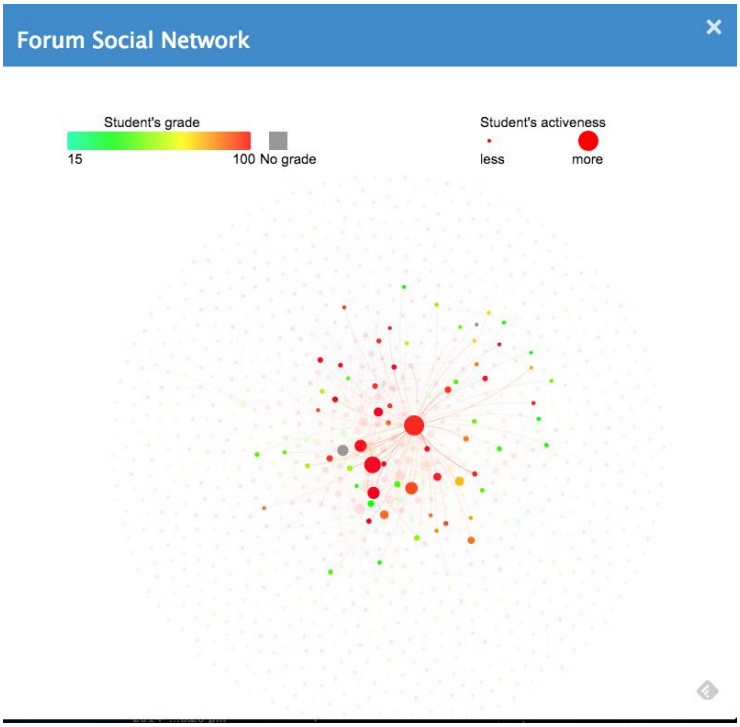



*Note. This sociogram illustrates the connections among active and less active students in a MOOC discussion forum. The colours indicate a student's final grade in the course.*

*Figure 2* shows that if you click on a large red node (a participant who passed the course), you can see that the participant interacted with many other participants.

**Figure 2**

*Visualization of an individual who passed a MOOC and their connections within a social network discussion forum data*

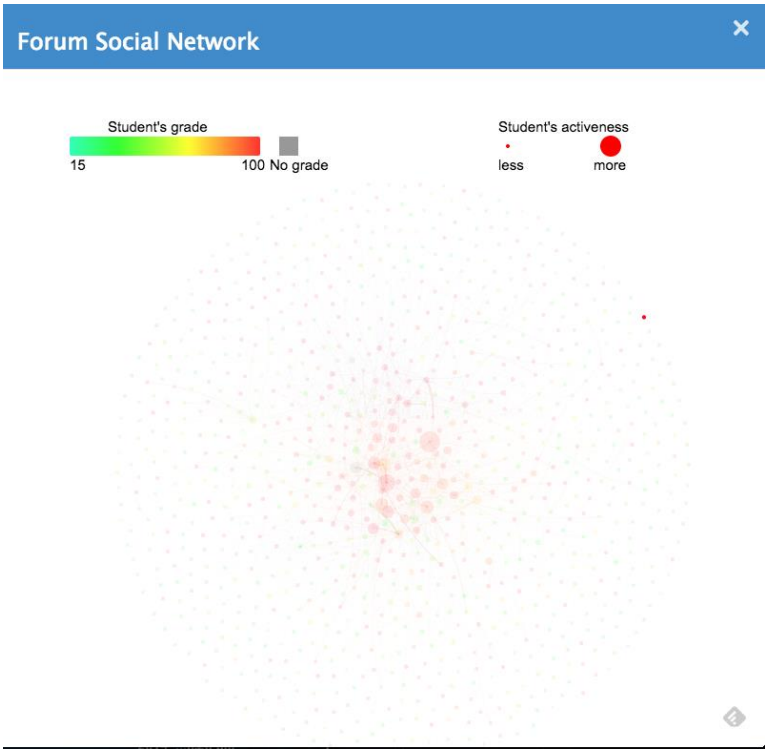



*Note. This image focuses on the most active student (red, centre node) and their connections to other students across the discussion forum within the learning network across.*

*Figure 3* shows participants that passed the course but did not engage in the discussion forum at all. All of this is useful data; however, it is extremely limited in telling researchers how the participants are connecting to each other (or not) and why. Furthermore, it reveals little about how connectors and their social ties in a MOOC discussion forum support or enable knowledge construction. This purpose of this study is to identify connectors and how they support knowledge construction in MOOC discussion forums.

**Figure 3**

*Visualization of an individual who passed a MOOC and the lack of their connections within a social network discussion forum data*




Note. *This image focuses on the least active student (upper right) and their connections to other students across the discussion forum within the learning network across. Notice here that this student is not connected to anyone.*

## 1.5 The research setting

This study investigates the role of connectors in xMOOC learning networks, particularly through connections made within the discussion forums. MOOC discussion forums are often designed to provide a venue for participants to interact with each other and engage in

discourse on course content so that learning or knowledge construction may occur. But, as mentioned earlier, it is not always clear whether some participants in xMOOC are more influential than others in how knowledge is shared, understood or constructed, and whether the connections are "good" enough for learning to occur. However, we do know from literature, that some participants do engage in discussion forums more than others. To answer these questions, this study analyses xMOOC discussion forums in two iterations of a case involving participants who interact in a learning network through edX. Two xMOOC courses offered by HKUST through edX have been chosen where this case occurs. They are:

- *English for Doing Business in Asia – Speaking* offered in 2014
- *English for Doing Business in Asia – Speaking* offered in 2016

While there are specific learning outcomes designed into each course with clear tasks, including summative and peer assessment, participants are given opportunities to engage in the discussion forums. There are clear discussion prompts throughout the course, encouraging students to interact and construct new knowledge of content related to communication theories, cross cultural communication, and general business communication subjects. Identifying and distinguishing possible connector types and the common ties they make and how and what content they discuss would provide some insight on how knowledge is constructed.

This study involves two iterations of a case where the emergent phenomena of knowledge construction occurs as the result of MOOC participants connecting and interacting with

each other in discussion forum threads. Because data from two different MOOC courses was collected, this research is considered a mixed methods case study where the case choice is based on the following criteria:

(1) MOOC type: All MOOCs follow the xMOOC model,

(2) MOOC platform: The MOOC provider is edX and the courses are delivered on similar learning management systems,

(3) Course design: All courses follow a similar course design that include weekly modules, each with learning sequences of video lectures (5-10 mins), review questions, quizzes, discussion forum activities, and exams,

(4) Institution: All courses are offered by the Hong Kong University of Science and technology. The purpose for this criteria is mainly due to accessibility issues, and

(5) Duration of course: The duration for each course is (6-8 weeks).

Although each course covers a different subject, it is believed that the above similarities offer participants a similar experience. The courses have already been delivered and are:

- English for Doing Business in Asia – Speaking offered through edX September 2014,
- English for Doing Business in Asia – Speaking offered through edX June 2016,

xMOOCs are usually organized by weekly modules, which consists of weekly discussion forum activities based on each module topic.

## 1.6. Research questions

As stated earlier, the goal is to explore how connectors engage in xMOOC discussion forums, whether some are more influential than others in how knowledge is shared, understood or constructed, and whether the connections are "good" enough for learning to occur. Literature does provide some insight on participant engagement in MOOCs, but as stated earlier, it does not provide any insight to the problems outlined in this study. There is extensive literature available about knowledge construction within online discussion forums; however, research is lacking in how this knowledge may be applied to xMOOCs, given their potentially large cohorts. There is little, if any research on the role or categorization of connectors in xMOOCs and whether they have any impact on how knowledge is shared, understood or constructed. Identifying and analysing connectors' impact on the quality and quantity of knowledge construction as an emergent phenomenon in xMOOCs has pedagogical importance because it can inform online teaching and learning practices and design. For example, online course activities that involve discussion forum participation can be designed to exploit or identify participants that are highly connected to quality knowledge construction. Or engagement prompts and tasks can be designed to guide xMOOC participants towards developing both strong and weak ties with cohort members to strengthen knowledge construction and sharing.

This study addresses the following questions:

1. What are the categories of connectors that emerge from participants' social ties in an xMOOC?
2. How do these connectors support knowledge construction in the discussion forums?

## 1.6 Research approach

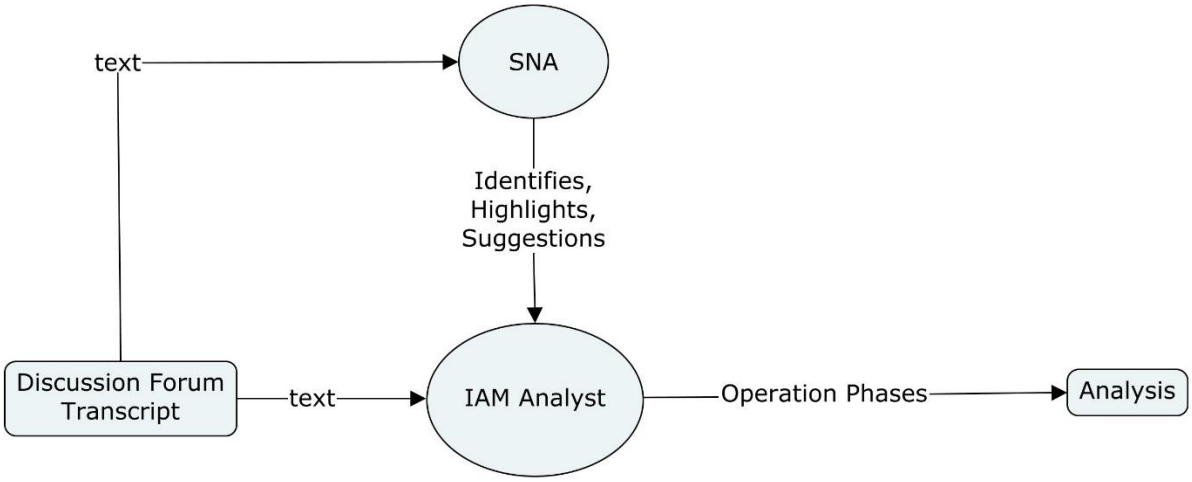
This study adopts a pragmatic worldview outlined by Creswell (2013) and Tashakkori and Teddlie (1998) in that "truth" is "what works" and that the world is both external to the mind and in the mind. Based on this, it is assumed that the actions of participants in MOOCs and the consequences of their actions are idiosyncratic to each course. This is also related to views suggested by complexity theory, where two particular features, as described by Cohen, Manion, and Morrison (2007) and Morrison (2008), are related to cMOOCs and xMOOCs: (1) connectedness, which requires a distributed knowledge system, and (2) emergence, which suggests that self-organization emerges internally in a system. In this sense, both categories of MOOCs are autocatalytic, in that a system of networked learners can evolve itself, from within. Morrison (2008) also notes that complexity theory suggests:

> that the conventional units of analysis in educational research (e.g. individual, institutions, communities and system) should merge, so that the unit of analysis becomes a web or ecosystem, focused on, and arising from, a specific topic or centre of interest (p. 28).

Considering this, a mixed methods approach that adopts Gunawardena et al. (2016) calls for combining SNA and Interaction Analysis Model (IAM) to analyse the social construction of knowledge in online discussion forums. SNA is used as a process that assists, not substitutes, IAM to help identify connectors and their social ties (see *Figure 4*).

**Figure 4**

*SNA as a process that assists, not substitutes for, the analyst (adapted from Gunawardena et al. 2016)*




*Note. Text in this figure refers to the same discussion forum transcript for each analysis (SNA, IAM).*

## 1.7 Impact of research

Because empirical studies on xMOOCs are still relatively new, it is expected that this research will provide additional insight on the subject of knowledge construction in MOOC discussion forums. As mentioned, there are gaps in the literature on how knowledge construction occurs in MOOC discussion forums, plus on how researchers might develop new methodologies for analysing learning outcomes in MOOCs. Furthermore, it is also expected that the results from this study can inform practitioners on instructional design of MOOCs. For example, by researching connectivity, centrality measures and knowledge construction in MOOC discussion forums, the findings can inform MOOC designers on how to best facilitate participant engagement to encourage collaborative dialogue, which is the

cornerstone of knowledge construction. Finally, this study may also provide insight on a mixed methods approach to analyse learning outcomes in MOOCs, particularly through a social network analysis approach.

## 1.8 Limitations and weaknesses of my research

There are some limitations in this project I need to consider. For example, because I am using a sample from English language courses, I cannot say the results are generally applied to all MOOC courses. Additionally, due to the nature of MOOCs, I will be analysing the engagement of participants whose demographics (i.e. age, nationality, education, gender, language proficiency) greatly vary; how this impacts social ties may be beyond the scope of this study.

## 1.9 Summary of Chapter 1

This chapter introduced historical background on MOOC research, identified a gap in the literature and defined the research problem of analysing knowledge construction in xMOOCs. Particularly, the chapter describes how a social network analysis approach in combination with content analysis of discussion forum messages can be adopted to measure knowledge construction in MOOCs. It was explained that the concept of connectors can be used as a unit of analysis, by identifying potential key participants who may provide pivotal messages to enable knowledge construction. The goal is to add to the research about learning outcomes in xMOOCs to help inform both researchers and

practitioners. The chapter concludes by explaining the impact of this study and the limitations and weakness of the research.

### 1.9.1 Overview of the remainder of the thesis

- Chapter 2: Reviews and evaluates relevant literature on MOOCs, learning, connectivity and networks, social network analysis, and knowledge construction.
- Chapter 3: Defines the methodology and methods used, explaining the quantitative and qualitative data collection and analysis.
- Chapter 4: Describes and explains the findings of the mixed methods approach. This includes a discussion on the social network analysis, which informs the following IAM content analysis. Both research questions are addressed in this chapter.
- Chapter 5: Provides an overall conclusion regarding this research, explaining the impact and limitation of the research.

# Chapter 2: Literature Review

This chapter reviews the literature on MOOCs, in particular MOOCs and learning, participant engagement, knowledge construction in asynchronous discussion forums, and the role of connectivity and social ties in networks in relation to online learning in MOOCs. The chapter begins by reviewing literature on MOOCs with the purpose of showing a gap in research about learning and knowledge construction in MOOCs. The following sections review literature on knowledge construction in online courses and how our understanding of connectivity and networks can inform our understanding of leaning in MOOCs. This is followed by a review of literature on social network theory and how social ties might be able to enlighten our understanding of how MOOC participants impact learning and knowledge construction. Building on this, the chapter reviews literature on knowledge construction in online discussion forums and, in particular, the sequential patterns of knowledge construction and the analysis of pivotal posts that influence the sequence. From there, this chapter provides an overview on literature related to knowledge construction and how it can inform research on MOOCs and learning.

## 2.1 Massive Open Online Courses

The concept of MOOCs was first used in 2008 when scholars Stephen Downs and George Siemens led a course called *Connectivism and Connectivity Knowledge*, which focused on exploring open online learning and Connectivism as a learning theory (McAuley, Stewart, Siemens, and Cormier, 2010; Stracke, Downes, Conole, Burgos, and Nascimbeni, 2019). As

McAuley et al. (2010) note, the course was not content-focused and was designed to explore "network formation among participants and the sharing of resources and contributions across those networks". It should be noted that the history of online learning does not begin with MOOCs; however, what made MOOCs unique at the time was that they were designed to enrol massive numbers of students, be open access, and be fully online, making use of social media and other internet tools so participants could distribute, interpret and collaborate on course content. The earliest MOOCs were described as "an experiment in a new pedagogy, a new learning ecosystem, where people build contents and where learners are the course" (Rodriguez, 2013). McAuley et al. (2010, p. 4) defined MOOCs as:

> An online phenomenon gathering momentum over the past two years or so, a MOOC integrates the connectivity of social networking, the facilitation of an acknowledged expert in a field of study, and a collection of freely accessible online resources. Perhaps most importantly, however, a MOOC builds on the active engagement of several hundred to several thousand "students" who self-organize their participation according to learning goals, prior knowledge and skills, and common interests. Although it may share in some of the conventions of an ordinary course, such as a predefined timeline and weekly topics for consideration, a MOOC generally carries no fees, no prerequisites other than Internet access and interest, no predefined expectations for participation, and no formal accreditation.

What is important here is how these definitions place a focus on participants' connectivity among and with massive groups of students, all of which is relevant to this study. In other words, MOOCs were opening new possibilities for exploring how collaborative learning and

knowledge construction can occur in online courses that have a large population of highly connected participants. However, at this point, literature at the time focused on the theory of using open resources on a massive scale in a learning network that is open access or exploring how MOOCs reflect practices within a digital economy (McAuley et al., 2010; Rodriguez, 2013; Stracke et al., 2019).

MOOCs quickly caught the attention of numerous educators and entrepreneurs, resulting in the formation of Coursera, EdX and Udacity, prompting *The New York Times* to declare 2012 the year of the MOOC (Pappano, 2012). As mentioned in the introduction, as a result of the growth in MOOCs, literature began defining MOOCs into two main categories: xMOOCs and cMOOCs (McAuley et al. 2010; Rodriguez, 2013; Stracke et al. 2019). xMOOCs are highly structured courses that centre around a series of short video lectures, automated marking, and peer evaluation. cMOOCs, are based on Connectivism, where participants build and navigate their own learning experience by choosing their own web connections (Siemens, 2006). Coursera, EdX, and Udacity courses are examples of xMOOCs. As Rodriguez (2013) points out: "c and x-MOOCs represent very different formats of massive open online courses. Their pedagogical foundations, the different way in which social interactions happen during the courses sets them apart". What is of interest for this study is the xMOOC; however, the differences described in literature are not important. It can be argued that xMOOCs and cMOOCs share similar elements of participants' engagement, such as large cohorts enrolled in a course communicating through a discussion forum to fulfil a learning task or creating new knowledge about a topic. Connectivity among massive groups of participants occur in both c and xMOOCs, as does the potential for networked

learning and knowledge construction. As noted in the introduction, there is a limitation in approaching research with "broad brush description" of MOOCs because xMOOCs, cMOOCs, BOOCs, SPOCs, among others, share similar elements of participants' engagement, such as large cohorts enrolled in a course communicating through a discussion forum to fulfil a learning task or to create new knowledge about a topic (Storme et al. 2016). Because of this common thread, this literature review draws from literature on both c and xMOOCs.

As mentioned, Massive Open Online Courses (MOOCs) are relatively new in higher education and, as a result, contributions to literature is limited in the number of studies and broad in research or subject focus. There has been a steady increase in published literature on MOOC research since 2012 (Bates, 2012b, 2012a; Canal, Ghislandi, and Micciolo, 2015; DeSantis, 2012; Kovanovic et al., 2015; Lewin, 2013; Palacios Hidalgo, Huertas Abril, and Gómez Parra, 2020; Pappano, 2012), with a growing list of empirical studies on MOOC topics ranging from the subject of attrition rates (Coffrin et al., 2014), design (Maina et al., 2013), communication patterns (Gillani and Eynon, 2014) user behaviour (Brinton et al., 2013), use of social tools (Alario-Hoyos, Pérez-Sanagustín, Elgado-Kloos, Parada, and Munoz-Organero, 2016), learning analytics (Alario-Hoyos, Muoz-Merino, et al., 2016; Tseng et al., 2016) and research issues (Liyanagunawardena, Adams, and Williams, 2013; Montes-Rodríguez, Martínez-Rodríguez, and Ocaña-Fernández, 2019). Additionally, a few systematic reviews of the literature have been published on topics ranging from: published literature (Liyanagunawardena et al., 2013), origins, concepts and didactic applications (Palacios Hidalgo et al., 2020); research challenges (Sanchez-Gordon and Luján-Mora, 2018); self-regulated learning (Lee, Watson, and Watson, 2018); student

equity and social inclusion (Lambert, 2020); and self-regulated learning (Alonso-Mencía et al., 2020). There is also considerable MOOC research that focuses on clickstream data, which is also seeing a growing interest by researchers in the Computer Engineering disciplines (Alonso-Mencía et al., 2020; Brinton, Member, Buccapatnam, Chiang, and Poor, 2016; Shi et al., 2014; Veletsianos, Collier, and Schneider, 2015; Wu et al., 2016); however, much of this research often focuses on how to visualize MOOC participant interactions and social networks.

Liyanagunawardena et al. (2013) note that, while MOOCs have created an interest as a change agent in high education, the vast amount of data they generate has yet to provide a good understanding of how educators can understand their impact on education in general. As suggested, there is a growing body of literature exploring the implications and benefits of MOOCs on education (Gomez-Zermeno and Aleman, 2016; Lee et al., 2018; Liyanagunawardena et al., 2013; Vida Fernández and Webster, 2014). However, as Palacios Hidalgo et al. (2020, p. 854) argue: "clarification of such benefits and impact on learning processes together with an extended classification of MOOCs typologies, platforms and specific MOOC-related terms like 'specialization courses' is necessary". Palacios Hidalgo et al. (2020) review of literature also reveals while researchers have started to develop conceptual frameworks on aspects of MOOCs, and published on subjects ranging from the threats and opportunities in higher education, pedagogical approaches, hardware and software used in the courses, and participants' and creators' experiences and leaders, there is still a lack of research on learning processes in MOOCs. It is interesting to note that their review of literature also distinguishes a difference between categories of MOOCs, with

cMOOCs focusing on engagement and creativity and xMOOCs focusing on learning analytics, assessment, and critical discourse. Still, based on a review of literature for this study, there is a large gap in research about networked learning or knowledge construction, particularly in xMOOCs. Interestingly enough, Palacios Hidalgo et al. (2020) suggest that MOOCs do create learning communities with the "possibility of interacting with thousands of people", allowing participants in central roles to facilitate knowledge construction. However, they offer not empirical evidence that this does indeed happen. A review of literature on the subject of discussion forum participation should provide additional insight on this subject. However, as the next sections reveals, there is also a gap in the literature on this topic.

### 2.1.2 MOOCs, Discussion Forum and Participants Engagement

Most xMOOC platforms have a discussion forum; however, how teachers and students use the discussion forum may vary from course to course. Some xMOOC courses, in a similar fashion to cMOOCs, provide additionally social media tools for students to participate and discuss the contents of a course. Generally, discussion thread topics range from frequently asked questions, technically support, course content or general discussion. Research on participants' engagement in MOOCs, and more specifically their involvement in discussion forums, typically focuses on course attrition, learners' retention, patterns of behaviour, and learners' interactions (Sunar, White, Abdullah, and Davis, 2017). Sunar et al. (2017) note that most research in this area focuses on clickstream data and / or forum activity. For example, findings indicate that learners who contribute to discussions are less likely to

dropout, and that "the length of forum posts is more strongly predictive than the number of posts and responses. Still, there is nothing about the interactivity among participants and whether individual participants are pivotal in enabling learning to occur among the group. What is considered here is only the quantity of posts, not what is in the posts or how the content of the posts might impact participants' process in knowledge building and learning.

But it does seem to be a common approach to use the discussion forum as a tool for measuring learning in MOOCs. Coetzee et al. (2014, p. 1184) found that "users are more likely to post on the basic forum, but posts are more likely to be questions, and a larger proportion of questions are not answered, so these posts might not be productive". This is important to consider because it is not clear why the posts might not be productive. Coetzee et al. (2014, p. 1185) also found that "participation resembles a power law distribution: the top contributors author a substantial proportion of posts. In the full-featured forum, 43% of posts were by the top 5 users, and in the basic forum 21% of posts were by the top 5 users". As mentioned in the introduction, Gilliani and Eynon (2014) indicate that participants often start off with high-volume participation in on-line discussions, and over time, these conversations tailed off.

These findings are relevant in that it is assumed there are participants who are more engaged in the discussion forum than others. However, what is not certain is whether these participants have an impact on the learning outcomes of other participants or whether their contributions the discussion forums are pivotal to knowledge construction and learning in a MOOC. Researchers have attempted to identify and explain the implications of

participation in discussion forums. And it has been suggested that learners can be categorized by their forum participation. For example, suggested categories include lurkers, contributors or active participants (Clow, 2013; Koutropoulos and Gallagher, 2012; Milligan et al., 2013; Murray, 2014). While this may be useful in assisting facilitators with identifying students that should be encouraged to engage more in a course, it doesn't inform researchers much on the behaviour of the group and whether the engagement (or lack of) enables learning to occur. As Coetzee et al. (2014, p. 1185) note, "there is no simple way to analyse the forum without the effects of top contributors because the forum is a holistic system in which every post affects all users". It seems that earlier MOOC studies about discussion forum participation either focuses on attributing learning to posts by individual participants or focuses on the frequency or quantity of posts by participants to measure learning outcomes. Wise and Cui (2018b) note that the most basic approach is to measure discussion forum participation by the raw quantity of contributions learners make to discussion forums such as the number of threads contributed to or number of posts made. This is problematic because the quantity of posts is no longer considered "valuable evidence of learning" (Wise and Paulus, 2016).

### 2.1.3 MOOCs and learning

Despite the lack of research on networked learning and knowledge construction in MOOCs, there are a few empirical contributions in literature on learning in MOOCs (Deng et al., 2019). Yet, these studies rarely define what "learning" is. They often focus on learning goals or outcomes, not the process of learning as it occurs in a MOOC. Additionally, MOOC

literature scarcely links relevant findings from a vast body of literature on learning in discussion forums. For example, analysing learning in discussion forums requires different approaches due to the different perspectives on learning (Jones and De Laat, 2016; Gerry Stahl, 2006; Wise and Paulus, 2016). At present, there does not seem to be any exploration into whether learning is attributed to an individual or a group of learners in a discussion forum. As Wise and Paulus (2016, p. 271) note,

> in a neo-Piagetian model of learning, the contributions others make to an online discussion are treated as external inputs to stimulate cognitive conflict, leading to the growth of development of the individuals' conceptual structures which are then reflected in their future contributions.

There is a need for more discussion on how learning cannot always be understood in isolation or how learning cannot be reduced to a person and individualized cognition in MOOCs.

Still, much of the literature focuses on quantitative data to explain phenomena like attrition rates, connectivity, communication patterns or self-regulated learning (SRL). These phenomena are important in providing insight for better instructional design of MOOCs, but they are limited in how researchers can identify or measure any occurrence of learning, such as knowledge construction. For example, Alonso-Mencia et al. (2020) systematic literature review shows there is some research on how the instructional design of a MOOC and the way content is delivered affects the way learners use strategies to self-regulate their learning process. There are numerous issues that still need to be addressed:

> Studies on SRL in MOOCs face a great diversity of learners, and are conditioned by the MOOC, the population sample whose data is analysed and the research

> instrument used. It is noteworthy that the instructional design of the MOOC […] and the learning context [...] have a strong influence in the learning process. Therefore, the diversity of learning contexts in which SRL in MOOCs has been studied makes it difficult to generalize conclusions. (Alonso-Mencia et al., 2020, p. 321)

However, because the area of MOOC research is relatively new, one cannot draw conclusions on whether learning occurs, despite a few studies illustrating how MOOC participants use learning strategies.

In another study (Kizilcec et al., 2017), findings from a sample of 4,831 learners across six MOOCs based on individual records of overall course achievement, interactions with course content, and survey responses indicate that self-regulation strategies seem to have an impact on learning goals:

> We found that learners who reported engaging more in goal setting and strategic planning were more likely to attain personal course goals, such as earning a certificate, consistent with prior research on these strategies […]. In contrast, help seeking was a negative predictor of goal attainment, unlike in prior work […]. (p. 24)

This literature is useful for exploring self-regulation strategies, and should be considered when designing MOOCs to enable participants to achieve learning goals. What the literature does not provide insight on, however, is how student-to-student engagement might impact knowledge construction in a MOOC. Nor does it show how learning occurs in discussion forums.

Wise and Cui (2018b) make note of this gap in literature, suggesting how the conceptualization and operationalization of learning in MOOCs has been relatively similar (and narrow) thus far, focusing on course performance measures such as pass / fail and grades. In fact, literature often correlates these performance measures with forum participation (Guo and Wu, 2015; Jiang et al., 2014). Yet, these studies do not explore whether learning occurs, and, more specifically, whether the performance measures are a result of learning in a MOOC course. So far, it is not clear whether there truly is any correlation between forum participation and learning in MOOCs.

Wise and Cui (2018b) also rightly argue that this constructs 'learning' as a "black-box metric", where the actual contents of the metric may differ dramatically from one course to the next. Considering this then, it is difficult to generalize the degree of which MOOC participants' interactions in the discussion forums result in knowledge construction. Similar findings can be found in Coetzee et al. (2014) study where they state:

> The strong correlation between forum usage and student outcomes like retention and grades is difficult to interpret due to a range of possible confounding factors, which we explore below, but to the extent that a causal link exists, it may be attributed to the use of the forum to get "unstuck" when a student is unable to make progress in the course on their own. In learning theory terms, the student is operating in their zone of proximal development, which is considered important for advancing individual learning. In the absence of a forum, students frustrated by an obstacle are, intuitively, more likely to cease participation. It is therefore unsurprising that forum software is widely deployed in MOOCs today. (p. 1184)

What is significant here is that participants do use the discussion forums with an intent to interact with other participants to learn. In this sense, learning become social and the "group" is necessary for knowledge to occur.

What is equally important to consider is how literature defines or uses discussion forum participation when measuring the occurrence of learning. As mentioned, most literature looks at MOOC discussion forum data, which includes the text and written and published by participants (whether it's an initial post or a response to other participants, etc.). A problem with existing studies is that the findings correlate performance measures with the content in the discussion forums, only. What isn't considered is what is *not* said. In other words, whether participants have the chance to read other participants' posts. This becomes important when considering the process knowledge construction in an online network (to be discussed later). Wise and Cui (2018b, p. 332) argue that

> reading others' posts represents the reception of ideas (rather than the expression), which is critical to most models of learning through discussion and makes up the majority of times users spend in online forums […]. Furthermore, when non-posting behaviours are considered, the proportion of students in a MOOC who can be consider to have participated in (and potentially learned from) the forums grow dramatically.

There are MOOC studies that do consider non-posting activities for understanding learning; for example, one research study compares the final score of learners who visited the discussion forum at least once and non-forum-users who viewed at least one lecture, homework, or quiz in a MOOC course (Coetzee et al. 2014). Findings from that study found

that forum users' scores were significantly higher that non-users' scores (median score of 22% vs. 0%).

Score comparisons among discussion participants is only partly an indication that learning occurs. It is difficult to make a generalization because the literature does not define "learning" or provide a theory of learning to show whether the forum participation is a contributing factor to learning. The scarce literature that does examine learning in MOOCs does not seem to follow a defined approach to what entails learning. So far, it is not clear what it means to learn in a MOOC. As Stahl (2004, p. 2) notes "what authors mean by 'computer support', 'collaborative' or 'learning' are different every time someone else tries to define them." The purpose of the following sections establish how researchers might be directed by a theory of building knowledge, or knowledge construction, to measure whether and how learning occurs in MOOCs. According to Wise and Cui (2018b, p. 337),

> those who contribute to content discussions performed slightly better than those who did not (final grade of 87% vs 85%) […] these findings have important implications for MOOC research. First, they highlight the importance of differentiating discussion forum data based on content relatedness, especially when the research purpose is related to understanding of course content.

But what about knowledge construction? Or the role of participants in knowledge construction or the impact of their participation on learning within a learning network?

## 2.2 Learning, Connectivity and Networks

Interest in exploring how connectivity and networks impact learning appears extensively in various literature, extending from research areas on computer supportive collaborative learning (CSCL) (Stahl, 2004, 2005, 2006), to networked learning (Jones and Steeples, 2002; McConnell, Dirckinck-Holmfeld, and Hodgson, 2012) to Connectivism (Siemens, 2006), and to social network analytic perspectives in learning (De Laat, Lally, Lipponen, and Simons, 2007; Haythornthwaite, 2019; Haythornthwaite, De Laat, and Schreurs, 2016). Literature in these areas often frames definitions of online learning around how learners connect via a technology and through collaborative efforts. For example, a working definition of networked learning in 2002 is:

> […] those learning situations and contexts which, through the use of ICT, allow learners to be connected with other people (for example, learners, teachers/ tutors, mentors, librarians, technical assistants) and with shared information rich resources. Networked e-learning also views learners as contributing to the development of these learning resources and information of various kinds and types. (McConnell et al., 2012, p. 10)

McConnell et al. (2012) add that the definition implies that technology used to support networked learning affords two significant capabilities:

> 1. Its ability to support distributed collaborative interaction and dialogue, and
> 2. Its ability to support access to information-rich resources.

Another definition is offered by Goodyear, Banks, Hodgson, and McConnell (2004):

> Networked learning is learning in which information and communications (ICT) is used to promote connections: between one learner and other learners, between learners and tutors; between a learning community and its learning resources. (p. 1)

Meanwhile, Connectivism suggests that knowledge is "distributed across an information network and can be stored in a variety of digital formats […] Learning transpires through the use of both the cognitive and the affective domains; cognition and the emotions both contribute to the learning process in important ways." (Kop and Hill, 2008; Siemens, 2006).

Within this Connectivist approach to learning, knowledge construction occurs during sensemaking interactions, which includes information sharing, discussion, negations, reflection and decision making (Siemens, 2014; Wang et al., 2017). Some scholars, however, point to weaknesses in a Connectivist approach to analysing learning in networks (Anderson and Dron, 2014; Kop and Hill, 2008). For example, Anderson and Dron (2014) use the community of inquiry model to examine Connectivist pedagogy. They suggest that a Connectivist approach views learning as an emergent phenomenon greater than the sum of its parts. In this sense, for example, learning in a cMOOC emerges as a result of the connection made among participants. However, as Anderson and Dron (2014) argue learning in a Connectivist space is, paradoxically, plagued by a lack of connection. This is because there is often an undefined learning environment and a lack of guided paths towards specific learning goals (Anderson and Dron, 2014). In relation to this, Garrison (2015) points to the argument that MOOC participants "have trouble identifying sufficiently with large groups" and are unlikely to engage in critical discourse or contribute to thinking and learning collaboratively because they do not feel any strong connection to each other.

This leads to a distinction that needs to be made: the difference between *networked learning* and *learning networks*. As Goodyear and Carvalho (2014) point out, "networked learning cannot be designed – it can be designed for" (p. 11). A learning network, however, is something that can be analysed. For example, an xMOOC and its network of participants might be the core object to be analysed. Considering this, the learning network boundaries need to be clearly defined in order to analyse any occurrence of networked learning. In general, there seems to be a lack of any clear definition for what makes a learning network, and it's unclear how to distinguish one learning network from another (Goodyear et al., 2014). The literature so far mentioned is mostly concerned with online or distance learning in general. Researchers have yet to conduct substantial empirical research on knowledge construction in a clearly defined xMOOC learning network.

Anderson and Dron's (2014) point about how learning is an emergent phenomenon as a result of connected individuals and is greater than the sum of its parts raises an important issue about deciding on what units of analysis should be used when analysing a learning network. For example, "learning is not confined to the individual mind or the individual learner" (Ryberg, Buus, and Georgsen, 2012). The literature on networked learning also illustrates how connectivity can enable knowledge construction from a group. As Ryberg et al. (2012, p. 45) point out, "learning and knowledge construction is located in the connections and interactions between learners, teachers and resources, and seen as emerging from critical dialogues and enquiries". What is also key to these definitions of

networked learning is that they suggest learning is a social and relational phenomenon dependent on interaction and dialogue.

Ryberg at al. (2012, p. 45) also point to how Goodyear et al.'s (2004) definition of networked learning stresses "the connections *between* people and *between* people and resources, but also points to a certain level of social organization between learners, tutors and resources, i.e. a learning community". However, as they argue, Goodyear et al.'s (2004) definition focuses on learning communities, which, in turn, suggests strong ties among learners is essential for learning to occur. This becomes problematic when analysing networked learning in MOOCs because it is highly unlikely that all participants will have, or build, strong ties with each other given the sheer number of participants. Additionally, the notion of weak ties and the impact of those ties seems to be ignored in Goodyear et al.'s definition, something that has yet to be fully explored in MOOC research. "Simultaneously, proponents of networked learning also argue for learning and collaborative knowledge construction processes organized around focused and intensive negotiations of problems (Ryberg at al., 2012, p. 45). The strength of a tie(s) may have an impact on how negotiations of problems occur, and, as a result, influence the sequence of knowledge construction.

Literature suggests that there are various elements involved that enable or constrain connectivity among participants in a learning network. For example, Kumpulainen and Saadatmand (2013) note the phenomena of social serendipity, which is something that some participants in an open online course may experience as a result of being connected

in a learning network. However, Kop (2012, p. 3) suggests that power relations could limit connections and that "it is the presence and involvement of (knowledgeable) others in an environment characterized by many technological variables and contexts that helps learners to make sense of the multitude of resources offered on the Web". Hodgson et al. (2012) approach the subject from a socio-perspective, and suggest that networked learning is achieved through participation in communities of learners where meaning is both negotiated and created through collaborative dialogue. These studies touch on elements related to how participants' engagement and connectivity impact a learning network, each in a different way.

Houston et al. (2017) do explore the relationship between network position, engagements and course performance in MOOCs; although, their research is still preliminary. In their study, they investigate which types of forum engagement are most strongly associated with the final performance in MOOC courses by analysing direct and indirect measures of a learner's position in the learning network. "Direct metrics capture the extent to which one learner is exposed to the ideas or knowledge of another learner. Indirect metrics, on the other-hand, capture the extent to which a learner positions themselves to be exposed to a variety of other learners" (Houston et al. 2017, p. 297). Their preliminary findings suggest that students with direct measures have stronger correlation with final grades than those with indirect measures. Their findings are relevant in that their study shows how a social network analytical approach to online learning could offer new perspectives on connectivity and learning. However, partially because there has yet to be any follow up on their preliminary findings, it's not clear what happens among students with direct

measures. If students who directly interact with those they connect to in the discussion forum lead to successful grade results in a MOOC, an answer to the question of why is still needed.

### 2.4.1 Social Network Analytic Perspectives to Online Learning

A growing area of interest that does consider how connectivity and the strength of ties impact knowledge construction is the social network analytic perspective on online learning. For example, Gunawardena et al. (2016), Haythornthwaite (2019), and Haythornthwaite et al. (2016) suggest that approaches to social network analysis can build an understanding on the way learning can be defined in learning networks, "extending with consideration of information and knowledge". By examining learning, connectivity and networks, Haythornthwaite (2019, p. 23) argues that learning can be defined as a *relation* or as a *relationship*: from the perspective of *learning as a relation*, "learning networks can be constructed by asking 'Who do you learn from?' or 'Who learns from you?'"; from the perspective of *learning as a relationship*, learning is associated with "exchanges of information, co-construction of knowledge and common concern for an area of interest" based on multiple relations. This is relevant when measuring online learning from the perspective of social network analysis because it places importance on social ties:

> The perspective and techniques of social network analysis provide a toolkit for exploring learning where connectivity is the major area of investigation. The concepts of nodes, relations, ties and networks provide the framework for empirical inquiry into the range of relational content that makes a tie a learning tie, how the tie between people form networks of common understanding and shared practice

> and how common interest lays in groundwork for ties to build networks of people and resources. SNA is further used to understand the dynamics and patterns that exist within networks, to study the nature and meaning of the ties, and the network positions and roles that people might have within these networks. […] the unit of analysis has expanded from the traditional focus on the individual learner to the influence of social relationships on learning. (Haythornthwaite et al., 2016, p. 253)

In short, SNA can assist with analysing students' online interactions, and, as a result, provide approaches to understanding knowledge construction as a result of connectivity. While the empirical research appears to be scarce, there is a growing body of literature exploring areas such as: students' interactions in online asynchronous discussion forums (Chen, deNoyelles, Patton, & Zydney, 2017; De Laat et al., 2007; Eynon et al., 2016a; Gunawardena et al., 2016; Lucas, Gunawardena, & Moreira, 2014; Oshima, Ritsuko, & Matsuzawa, 2012; Wise & Cui, 2018a).

There are various ways in which researchers can approach SNA of learning networks. Haythornthwaite et al. (2016) provide a good explanation of the basics by describing how SNA can be used to analyse students as actors connected by relations and note how social network measures of centrality "are commonly used to assess position of an actor in a network and can be assessed with several different measures"; for example, degree centrality, betweenness centrality, and closeness centrality. As mentioned in the Introduction, SNA can help identify social ties among learners (Borgatti et al., 2013; Gee and Hayes, 2011; Dawson 2008) and identify students who may be central to the learning

network. Identifying students' centralities is useful in learning networks because it may reveal their role or impact on learning outcomes in the whole network.

> Individuals may act as sources or disseminators of information and of learning according to the information, advice, or other contributions to the learning they receive from others – their 'in-degree' learning connections – and what they share with others – their 'out-degree' learning connection. (Haythornthwaite et al., 2016, p. 256)

Dawson's (2008) study has already been mentioned as an example of exploring students' position in a network. His findings suggest that students with high levels of centrality are often "gatekeepers" or "brokers" and influence the flow of information and resources in the network.

### 2.4.2 Connectors, Social Ties and Roles

A SNA approach to analysing learning shows promising outcomes because it allows researchers to identify learners that may have an impact on a learning network, but there is still much to be studied in this area. With cMOOCs, Wang et al. (2014) argue that learning occurs not just through social interactions, but also through interaction with and between network nodes (people, media, places), because knowledge is distributed across a network of connections.

> Interactions extend from individuals to groups and networks, from closed to open, from small groups to massive possibilities. This affords opportunities for network

> development, potential to develop both strong and weak links, and opportunity to jump across or cross boundaries. (Wang et al., 2014, p. 125)

Dawson's study that identifies "gatekeepers" or "brokers" is helpful, but additional empirical research on roles in social learning networks is scarce. Jiang et al. (2014, p. 57) do suggest in their study that MOOC participants "with high degree have greater levels of participation in a variety of threads that put them in contact with other learners". Their study also notes how betweenness centrality measures the extent to which a participant bridges other participants: "Nodes with high betweenness have been described as having some degree of control over the communication of others as well as greater opportunities to exert interpersonal influence over others" (Jiang et al. 2014, p. 57). This supports what De Laat et al. (2007) argue in that centrality provides information about participants' interaction with others within a network.

As mentioned in the Introduction, students in online learning networks with high centrality scores are similar to what Gladwell defines as "connectors" and "mavens" in his book, *The Tipping Point* (2000). The metaphor and concept of connectors may be useful in identifying the roles of learners who have high centrality scores in a learning network. Although this doesn't seem to have been explored yet in educational contexts, the concept has been discussed in other disciplines. For example, Kotowski and dos Santos (2010) have explored the role of connectors in bridging borders across communities and cultures.

> Consequently, connectors within groups on either sides of a border serve a key function in communicating across borders because they are motivated to interact with new people and are not as prone to stereotyped biases as the contact hypothesis would predict. (Kotowski and dos Santos, 2010, p. 153)

Within a business context, scholars have explored how connectors often have weak ties and accommodate knowledge transfer, or how agents with weak ties in a network are often those who have high betweenness centrality and can be referred to as 'brokers' of knowledge transfer (Hansen, 1999; Levin and Cross, 2004).

Up to now, literature is very scarce in exploring social ties and the role of "connectors" in online learning and knowledge construction in MOOCs (or online learning, in general). Again, Gladwell's (2000) definition of "connectors" and "mavens" sometimes become blurred and are often the same thing within a virtual network (Nichani and Hung, 2002). For the purpose of this study, the following definitions of connectors is used:

> Connectors: These are people who know lots of other people. They have the extraordinary knack of making friends and acquaintances. These are people who always remember to send you a birthday card, and who will follow up even after a brief meeting. They occupy several social circles, and "their ability to span many different worlds is a function of something intrinsic to their personality, some combination of curiosity, self-confidence, sociability, and energy.
>
> Mavens: These are people who connect other people with information. They are information specialists, or ''information stewards." These people are obsessed not only with collecting information, but also with wanting to tell other people about it- "The fact that Mavens want to help, for no other reason than because they like to help, turns out to be an awfully effective way of getting someone's attention". (Nichani and Hung, 2002, p. 253)

From this point forward, the term 'connectors' is used, only. So far, there is little, if any, research on weak and strong ties, or connectors in xMOOCs.

Connectors as learner types have pedagogical importance because their relations and connections among xMOOC participants can provide insight on the quality and quantity of knowledge construction and sharing. Knowledge creation in an educational context is a collaborative process (R. Garrison, 2011). And potentially rich network structures that can emerge in xMOOCs as a result of participants' engagement with each other allow for collaborative knowledge creation to occur (Goodyear, 2014). In other words, the connected experiences of participants can impact knowledge creation and sharing. For example, knowledge construction may be impaired when participants are marginalized or, conversely, rely on a focused core of members (Wenger 1999; Oztok et al. 2013). Gaining insight on connectors, who create weak ties among participants and potentially bridge knowledge sharing, in an xMOOC can inform course designers of ways knowledge creation and sharing can potentially occur, in both quality and quantity. This could lead to pedagogical designs, for example, that reduce the number if marginalized participants, or bridge communication across clusters of participants who would not otherwise connect.

## 2.3 Knowledge, Knowledge Construction and Communities

As suggested in this chapter, there is considerable literature on the subject of knowledge, knowledge construction, and communities. Wenger (2000), for example, notes how "knowledge in practice is much more a living process than an object". In this sense,

knowledge construction is a social phenomenon dependent on interactions among people within a community (Lave and Wenger, 1991; Wenger, 1998). Garrison (2015)adds that for knowledge construction to occur, social and collaborative elements need to be present, such as social, teaching and cognitive presence. Siemens (2006) points to how knowledge is distributed across multiple agents (human and non-human) and that knowledge construction occurs through the connected interactions among those agents. Differences among these theories of knowledge construction often focus on topics ranging from: definitions of community and its membership, the impact of social capital, the boundaries of an environment in which knowledge construction occurs, and who (or what) impacts, initiates or influences knowledge construction. What is common among all these theories and frameworks is that they view knowledge construction as a social phenomenon dependent on some form of interaction among connected agents. Considering this commonality, xMOOCs can potentially be viewed as a learning network conducive to knowledge construction among connected participant. As noted, some empirical research with the goal of measuring knowledge construction is available for review, but as of yet there is nothing that helps clarify what knowledge construction looks like in a MOOC environment.

Of course, the study of knowledge construction in online courses is not new to MOOCs (Buraphadeja, 2010; Gunawardena, Flor, Gómez, and Sánchez, 2016; Gunawardena, Lowe, and Anderson, 1997; Heo, Lim, and Kim, 2010; Kanuka and Anderson, 2007; Lucas et al., 2014; Wise and Chiu, 2011; Zenios, 2011). Approaches and frameworks used to understand and measure knowledge construction in online courses range from:

Communities of Practice (Wenger, 1998), Communities of Inquiry (Garrison, 2011; Garrison 2015), Networked Learning (Goodyear et al., 2014; Jones et al., 2008; Jones and De Laat, 2016), and Computer-Support Collaborative Learning (Stahl, 2004, 2005, 2006). A common thread among all of these theories is that knowledge construction is a social phenomenon, requiring more than individual cognition. For example, Stahl (2004) provides a foundation for exploring what he terms "building collaborative knowledge". By crediting Scardamalia and Bereiter (1996), Stahl (2004) says the phrase "building collaborative knowledge":

> is intended to point to a core process in collaborative learning: a particular way in which a group may construct a new degree of understanding about the topic that they are investigating. This new knowing is something that the group creates that cannot be attributed to the mental processes of any one individual. (Stahl, 2004, p. 2)

Much of Stahl's arguments are grounded in social theories of learning and focus on the phenomenon of building collaborative knowledge, "where group members invent knowledge and skill together that none of them would likely have constructed alone" (Stahl, 2004, p. 3). Stahl (2004, p. 6) adds that a theory of CSCL "is meant to provide a way of looking at social interactions in terms of inter-related phenomena and concepts such as: 'artefact', 'situation', 'meaning', 'interpretation', 'tacit knowing', 'perspectives', 'negotiation', 'internalization'".

Considering this, then, one can draw parallels to Connectivist approaches for measuring knowledge construction in MOOCs, in both cMOOCs and xMOOCs (Siemens, 2006;

Haythornthwaite et al. 2016). MOOCs, by design, enable an environment to exist where social interactions involving inter-related phenomena can occur. However, there has yet to be any substantial research of knowledge construction (KC), particularly on xMOOCs. Most research related to networked learning and participants' engagement or interaction patterns focus mainly on cMOOCs (Kop, 2012; Kumpulainen and Saadatmand, 2014; Wang et al. 2017). Kop's (2012) findings suggest that most participants in cMOOCs need guidance from course facilitators and other participants to enhance the "community" by creating and distributing content through social media. According to their findings, without those key agents, few participants add to what he calls the "creation" stage. But as Kumpulainen and Saadatma (2014, p. 25) argue:

> While the MOOC learning environment opens up new forms of scholarship and learning in higher education, it also demands from students a range of technological and open learning and networking skills. Many learners readily adapt to the new challenges. Others may not be enough equipped or motivated to keep up with such challenges.

This seems to be supported by Wang et al. (2017). Their findings suggest that most participants engage in four levels of interaction: operation interaction, wayfinding interaction, sensemaking interaction, and innovation interaction. Wang et al.'s (2017) identify that resource aggregation and sharing, discussion and negotiation, reflection, and decision making occur in sensemaking interactions. For example, publicly agreeing or disagreeing. However, their study does not go into depth on how a sequence of interactions among participants contribute to knowledge construction. Additionally, it's not clear what the knowledge construction outcomes are from those interactions, or which participants

were pivotal in the outcomes. What is also problematic about drawing any generalization that these studies consider participants' interactions across multiple social media (i.e. discussion forums, blogs, websites, etc.), making it difficult to identify the sequencing of knowledge construction.

Social network analysis (Haythornthwaite et al. 2016) and networked learning (Jones and De Laat, 2016) can also be explored to understand how knowledge construction occurs in the discussion forums. For example, literature on networked learning explores the concept of strength of ties and that "the spread of ideas depends not on so much on close contacts but on acquaintances or weak ties" (Jones and De Laat, 2016, p. 47). Building on Stahl's (2004) concept of "building collaborative knowledge", and similar to Connectivism and networked learning, one can consider how learning is "reciprocal interaction between the group and the individual" (Wise and Paulus, 2016p. 271). Yet, there is scarce (if any) research that examines knowledge building as a group process in MOOCs, despite the widely available literature on the subject for other online course phenomena. Additionally, there has yet to be any empirical study that examines who influences the process of knowledge construction or whether there are any pivotal moments in the discussion forum that initiate knowledge construction.

Eynon et al. (2016, p. 208) offer a good argument on why it is important to research how MOOC participants learn in relation to their connection to others in the course and how they communicate and collaborate meaning in the discussion forums:

> When an individual learns something, it is both their behaviour and their experience of that behaviour that is important; and this experience is shaped by the context of

> which they are part of, which can involve other people. Considering the learning environment and affordances of MOOCs, it is clear that the 'social' and communication form important aspects of such contexts. The reason we emphasize the role of communication in MOOCs, and what this means for leaning, is because when one considers what MOOCs can potentially offer learning that previous incarnations of open education initiatives have not, we are that MOOCs are unique in the way that they offer an opportunity for thousands of learners from diverse geographical location with varied experience to participate and collaborate with each other with physical presence.

They conclude that researchers need to go beyond data mining like using, clickstream data or the number of posts in a forum, or qualitative research, like discourse analysis of discussion forums, alone to understand the complex process of learning in a MOOC. They argue that "a more robust, holistic understanding of how people learn" is needed, which can be accomplished by mixed methods of both quantitative and qualitative data, particularly combining approaches to social network analysis and content analysis (Eynon et al., 2016, p. 208) . De Laat et al. (2007, p. 99) argue that it is important when studying CSCL "to not only focus on overall patterns of participation, collaboration and knowledge construction during […] CSCL, but to take into account the evolution of these processes over time". While research on knowledge building in online learning and CSCL is substantial, most of it is related to groups of learners in learning networks much smaller than what would appear in MOOCS. As this review of literature has shown, there is a lack of research on the process of knowledge construction in MOOCs.

### 2.3.1 KC and Patterns

A well-known model used for measuring levels of knowledge construction is the interaction analysis model (IAM) (Gunawardena et al., 1997). The IAM considers knowledge construction to be a social phenomenon and conceptualizes the KC process in five phases: (1) Sharing Information, (2) Exploring Dissonance, (3) Negotiating Meaning, (4) Testing and Modifying, and (5) Summarizing and Applying. A key point that Gunawardena et al. (1997) make is that knowledge construction is not repetition, and necessitates higher order thinking. *Table 1* illustrates the five phases in detail.

**Table 1**

*Interaction analysis model for examining social construction of knowledge*

| |
|---|
| PHASE I: SHARING/COMPARING OF INFORMATION.<br>Stage one operations include:<br>A. A statement of observation or opinion<br>B. A statement of agreement from one or more other participants<br>C. Corroborating examples provided by one or more participants<br>D. Asking and answering questions to clarify details of statements<br>E. Definition, description, or identification of a problem |
| PHASE II: THE DISCOVERY AND EXPLORATION OF DISSONANCE OR INCONSISTENCY AMONG IDEAS, CONCEPTS OR STATEMENTS.<br><br>Operations which occur at this stage include: |

| |
|---|
| A. Identifying and stating areas of disagreement<br>B. Asking and answering questions to clarify the source and extent of disagreement<br>C. Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view |
| PHASE III: NEGOTIATION OF MEANING/CO-CONSTRUCTION OF KNOWLEDGE<br>A. Negotiation or clarification of the meaning of terms<br>B. Negotiation of the relative weight to be assigned to types of argument<br>C. Identification of areas of agreement or overlap among conflicting concepts<br>D. Proposal and negotiation of new statements embodying compromise, co-construction<br>E. Proposal of integrating or accommodating metaphors or analogies |
| PHASE IV: TESTING AND MODIFICATION OF PROPOSED SYNTHESIS OR CO-CONSTRUCTION<br>A. Testing the proposed synthesis against "received fact" as shared by the participants and/or their culture<br>B. Testing against existing cognitive schema<br>C. Testing against personal experience<br>D. Testing against formal data collected<br>E. Testing against contradictory testimony in the literature |
| PHASE V: AGREEMENT STATEMENT(S)/APPLICATIONS OF NEWLY-CONSTRUCTED MEANING |

A. Summarization of agreement(s)

B. Applications of new knowledge

C. Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction

Lucas et al. (2014) revisit the IAM, arguing that, while it has become a common tool for analysing knowledge construction in asynchronous discussion forums, there is still a gap in literature that considers the impact of social web tools. This is even more true so now after considering the introduction of MOOCs. Lucas et al. (2014, p. 575) also point out that researchers have since used different interaction analysis models for examining knowledge construction in discussion forums,

> such as (i) critical thinking (Garrison, Anderson, and Archer, 2001; Meyer, 2004); (ii) social and cognitive presence (Garrison, Anderson, and Archer, 2001; Tu and McIsaac, 2000); (iii) problem solving (Hou, Chang, and Sung, 2008); (iv) emotional expression (Quan and Ren, 2010) or (v) knowledge construction (Cobos and Pifarre, 2008; Gunawardena et al., 1997; Schrire, 2006).

However, what makes the IAM a reliable tool for analysing knowledge construction is that it treats an entire message as the unit of analysis, not single words, phrases or sentence levels within a message. This is important because doing so considers the social constructivist approach to knowledge construction in that a message as a unit of analysis should be measured in relation to previous messages, and, "unlike breaking up a message into smaller units that cannot be readily identified, messages are clearly demarcated in the

transcripts, and, thus, multiple coders can easily make decisions about coding (Buraphadeja, 2010; Gunawardena et al. 1997; Lucas et al., 2014; Wise and Chiu, 2011). Considering this then, the exchanges of messages in a learning network becomes the primary focus, and the messages as an interaction among participants becomes the unit of analysis (De Laat, et al., 2007).

Findings from past studies that use the IAM suggest that higher phases of knowledge construction (Phases 4-5) rarely occur in online course discussion forums, particularly without guided help from teachers or assigned roles for students (Wise and Chiu 2011; Lucas et al. 2014). Reasons given for this are that members of a course may need time to know and understand each other before partaking in collaborative dialogue, goals are not set to initiate higher levels of thinking, or there is a lack of moderation to facilitate strategies for collaborative dialogue (Lucas et al. 2014). So far, it's unclear whether any of this occurs in xMOOCs. For example, the literature lacks any exploration of facilitating collaborative dialogue, goal setting for higher levels of thinking, or encouraging negotiation and synthesizing of meaning among participants. As mentioned earlier, literature suggests that these elements are often integral to higher levels of knowledge construction to occur. And, more relevant to this study, it's not clear whether specific participants are more likely to contribute messages that exhibit higher levels of thinking or contribute to the sequence of messages that enable higher levels of knowledge construction.

Considering this, it is not clear whether or how a sequence of messages within a learning network impacts knowledge construction. And, considering this notion, there is very little

empirical research that helps to identify whether particular messages or learners who post those messages have an impact on the sequence of knowledge construction. Wise and Chiu's (2011) study on analysing temporal patterns of knowledge construction in online discussion forums provides a way in which researchers can identify pivotal posts that initiate new segments of discussion that impact knowledge construction outcomes. This appears to be a useful tool for identifying participants in a learning network who might play a pivotal role in knowledge construction. Based on Gunawardena et al.'s (1997) Interaction Analysis Model, Wise and Chiu (2011, p. 447) argue that "While Gunawardena et al.'s (1997) model conceptualizes knowledge construction as a process which occurs though learners' interactions (via their posts), previous work has not capitalized on its capacity to examine this process by analysing patterns of KC". For example, an online discussion can follow a sequence of KC phases with the following pattern 111232332, where each number represents a KC phase. Wise and Chiu (2011, p. 447) add that "By treating KC as an aggregate outcome of individual contributions, prior studies failed to test a central underlying premise of the model: groups construct knowledge through a specific sequence of phases." Their study defines the following theoretical predicted patterns for identifying sequences of knowledge construction when analysing asynchronous discussion forums:

- 1a: Strictly progressive segments for each KC phase

  This pattern suggests that KC is an interdependent process and a cumulative group effort and progress depends on and influences the group members (e.g. 222**3** → 33433)

- 1b: Progressive and regressive segments for each KC phase

  This pattern also suggests that KC is an interdependent process, however, progress may be regressive. For example, after a segment of higher KC phases (i.e. Phase 3, 4), a participant may return to a lower phase (i.e. Phase 3) and others follow suit (e.g. 222**3** → 343**2** → 2212).

- 2a: Strictly progressive segments, but some KC phases skipped

  This pattern is similar to Pattern 1a, however, a KC pattern may be skipped as the thread progresses (e.g. 11211**3** → 3333)

- 2b: Progressive and regressive segments, but some KC phases skipped

  This pattern is similar to Pattern 1b, however, a KC pattern may be skipped as the thread regresses (e.g. 11211**3** → 333**3**→1111)

- 3: Mixed KC phase segments

  This pattern suggests that no specific KC Phase dominates the discussion (e.g. 1212**3** → 34323)

- 4: No distinct segments of KC

  This pattern suggests that no distinct KC Phases occurs and no pivotal posts are identifiable (e.g. 1212334323).

A key point to this is the notion that knowledge construction phases are an increasing sequence. As Wise and Chiu note (2011),

> Viewing KC as an interdependent process and a cumulative group effort, an individual's progress through the phases depends on and influences other group members, stimulating them to proceed through the phases more-or-less together. Transitions between the phases can thus be viewed as initiated by a 'pivotal post:' a

> contribution by a student (or the instructor) which changes the mode of discussion from one phase to another. (p. 448)

What makes Wise and Chiu's (2011) approach to using the IAM as a tool for analysing discussion forums in a learning network is that it places an emphasis on identifying the sequence of the how and what of knowledge construction that is occurring in a discussion forum and identifying which posts are pivotal for it to occur. As mentioned, MOOC participants have been identified and categorized in discussion forum activity (e.g. lurker vs active; highly connected vs isolated); yet, the literature has not explored the sequential patterns of knowledge construction and the role that the categorized participants have in impacting the process. There is also a gap in literature that considers this approach through the lens of social network analysis within a large learning network such as a MOOC.

Studies of undergraduate class's discussion forum activities, like Chen and Huang (2019), have explored measuring the degree centrality of students and comparing the outcomes of interactions based on high degree and low degree scores. Findings from their study suggest that students with high centrality and strong ties did not help bridge connections among students who had less degree centrality (Chen and Huang, 2019). Their findings also indicate that the low-degree centrality students' attempts to interact with the "high-prestige" were rarely reciprocated, and that the "high-prestige" students mostly interacted amongst themselves:

> Higher prestige students were more connected, had more reciprocal and persistent connections, were closer to peers, and were connected with similarly high-prestige

> peers; however, they did not occupy more favourable positions in terms of bridging peer connections. (Chen and Huang, 2019, p. 512)

Would this be the same in a MOOC, which is by definition designed to encourage connectivity and knowledge transfer in a large network of learners? And what about the role of weak ties? Chen and Huang's (2019) study suggests that high connectivity in a learning network does not necessarily mean weak ties occurs in the learning process. In fact, their findings suggest that highly centralized students in a learning network may gravitate more towards other highly centralized students, excluding (perhaps, unintentionally) those who may not be contributing to the discussion forum. Of course, one issue with this perspective is that it assumes that posts made by high-centralized students are pivotal in the learning process. So far, literature lacks empirical studies that explore the sequence of posts to see whether connectivity does matter. For example, the question of whether a student who has low centrality (i.e. few interactions in the learning network) can post a message that influences knowledge construction needs to be analysed in more detail. The same for a student who has high centrality in a learning network.

Wise and Chiu's (2011) study using predicted patterns of KC shows that particular roles played out by students or instructors can have an impact on the Knowledge construction patterns. For example, roles adopted by participants might be that of the "starter", who provides new ideas, the "questioner", who asks the group to elaborate on ideas, or the "devil's advocate", who takes a contrary position to groupmates. What is significant here is that Wise and Chiu (2011) show that participants with certain roles can produce pivotal posts that assist the group in achieving higher levels of knowledge construction. For

example, a participant with the role of reflecting and wrapping elevated knowledge construction in a sequence of posts (e.g. 12123 → 32333).

### 2.3.2 Participants, roles, and KC in a MOOC learning network as a complex system

Researchers are beginning to explore the concept of learning networks as complex systems (DeWaard, Abajian, and Gallagher, 2011; Nakano, Padua, and Jorente, 2015; Schreurs, Cornelissen, and De Laat, 2019). Mitchell (2009, p. 13) defines a complex system as "a system in which large networks of components with no central control and simple rules of operation give rise to complex collective behaviour, sophisticated information processing, and adaptation via learning or evolution". A key phenomenon that occurs in complex systems is emergence, which can be described as an entity or behaviour that emerges from the interactions of the components within the system (Cohen et al., 2007; Mitchell, 2009; Morrison, 2002, 2008). In the context of learning networks, emergence inlcudes learning ties between learners and their peers, or learners and their instructor or learners and their learning objects, and is, at least partly, the result of a process of self-organization. Defining classrooms, online learning networks and MOOCs as complex systems is a relatively new idea in education research (Cohen, L., Manion, L. and Morrison, 2007; DeWaard et al., 2011; Morrison, 2002, 2008; Nakano et al., 2015) and needs further exploration; however, the concept of MOOCs as complex systems is useful in understanding how participants' roles and knowledge construction emerge as a result of their interactions in discussion forums.

For example, Nakano et al. (2015) argue that how MOOC participants construct knowledge (an emergent phenomenon) depends wholly on the design of the MOOC as a complex system. They posit that:

> MOOCs are self-organized, which means they are open to information flow, the participants are free to interact to each other and the tutor (or curator), free to bring information to the forums, free to relate, and connect to each other, and as a result a new complex phenomenon emerges. In other words, people are free to make their own decisions on the system. The participants are influenced by the relationships and the digital environment, and the converging languages, which altogether represent new forms of culture that re-shapes the individual, changing their sense of reality and vision of the world. MOOCs were primarily intended for knowledge dissemination however, the creators of the platform could nor foresee, at the time, the consequences of the connections and relationships could transform the way people interact and connect with the possibilities of the system. (Nakano et al., 2015, p. 127)

Conceptually, this is a powerful idea. However, their argument assumes that MOOC participants will spontaneously interact with each other, giving rise to a self-organized MOOC. To date, there is very little empirical evidence that this occurs. As de Waard et al. (2011, p. 112) note, there is still a need "to determine design principles for MOOCs to effectively maximize their self-organizing, self-referencing, and knowledge-producing capabilities". Schreurs et al. (2019, p. 2) make note of three self-organizing network effects: (1) preferential attachment, which "is a process in which tie formation is distributed among learners or learning objects according to the amount of online learning ties these learners

or learning objects already have", (2) reciprocity, "reflects the tendency of individuals to reciprocate a learning tie. Reciprocity measures a form of mutual engagement", and (3) transitivity, which "refers to the self-organizing effect in which learners tend to form groups". However, there is a lack of literature on how these effects occur in xMOOCs, and whether they enable knowledge construction to emerge as a result.

The concept of agent-based modelling in complex systems can assist with defining connectors, or participants who may play an influential role in a MOOC learning network. (Smith and Conrey, 2007, p. 87) note that:

> Most social and psychological phenomena—from attitude polarization in group discussion, to escalation of intergroup conflicts, to stereotype formation, to large-scale social trends in aggression or unhealthy behaviour—occur not as the result of explicit choices by isolated individuals but rather as the result of repeated interactions between multiple individuals over time.

As Morrison argues (2002, p. 5)

> None of us can exist independent of our relationships with each other. 'Complexity' derives from the Latin root meaning 'to entwine'; the notion that an organism interacts dynamically with its environment, influencing and, in turn, being influenced by its environment, is a key principle of the emerging science of complexity.

Morrison (2008, p. 20) adds that "the interaction of individuals feeds into the wider environment, which in turn, influences the individual units of the network; they co-evolve, shaping each other. This co-evolution requires connections, cooperation and competition".

Considering this, the discussion forums in a MOOC are a complex system with multiple agents. Each agent's, or MOOC participant's, ability to achieve its goals may depend on not only what it does but also what other agents do. For example, direct interaction among participants, or influential participant with high connectivity measures, in the discussion forum could have an impact on overall knowledge construction. As Smith and Conrey (2007, p. 88) note, agent-based modelling is a "tool to conceptually bridge between the micro levels of assumptions regarding individual agent behaviour, integrated interactions and so forth and the macro level of the overall patterns that result in the agent population". By taking an agent-based model approach to social network analysis, researchers may be able to identify and analyse interactions among participants, their social ties, the possible impact some highly connected participants have on knowledge construction. For example, identifying whether connectors, like "brokers", exist in the network.

As Wasserman and Faust (1994. p. 3) note, "social network analysts assume that interpersonal ties matter, as do ties among organizations or countries, because they transmit behaviour, attitudes, information, or goods […] Society […] is not an aggregate of individuals and their characteristics, […] but a structure of interpersonal ties". Considering this, participants in a learning network are viewed as interdependent rather than independent. This is a key point when analysing MOOC discussion forums as the behaviour of one participant (i.e. their post message) can influence other participants' contributions. This concept is important considering CSCL or knowledge construction, which will be discussed later in this chapter. In short, a relational tie among participants is a behavioural

interaction; it is also a transfer of knowledge or new ideas, which could lead to the construction of new knowledge.

This raises an important question: does existing literature present approaches that sufficiently capture the complexity of interaction between interrelated cognitive and social dimensions that emerge from social ties and collaborative discourse? Gašević, Kovanovic, Joksimovic, and Hatala (2019) address this question in their study of roles and connectivity in MOOCs by considering the following:

- the structure of social network ties with collaborative discourse,
- the students' role in group communications with collaborative discourse,
- collaborative discourse based on identification of high and low-achieving communities of learners, and
- academic performance.

Gašević et al. (2019) draw on literature that suggests that roles often emerge spontaneously or are negotiated spontaneously by participants in an online course, without the influence of the teacher. In other words, "emergent roles are eventually determined by contributions made by group members and by the ways how group members participated in interaction with their peers" (Gašević et al. 2019, p. 563). According to them there are three levels in which roles occur:

- Micro, where the role is related to a specific task focused on a collaborative process or product

- Meso, where the role involves a pattern of several tasks focused on process, product and their combinations, and
- macro, where a role is determined by a stance composed of an individual's participation strategy.

Examples of macros roles may be, communicative learners, silent learners, intermittent talkers, concentrated listeners. "A role is an ensemble of different dimensions that assume interacting with the right people at the right times and in the right ways." (Gašević et al., 2019, p. 563).

What is significant of Gašević et al.'s (2019) findings is that participants often choose to interact with peers who share similar interests and perspectives, building strong ties, and that participants with central roles often focused on specific topics. Their findings "indicates that students tended to form ties with a limited number of peers with whom they would have in-depth discussions with several rounds of responses" (Gašević et al., 2019, p. 573). What is important to note here is that in-depth discussion occurs, with students responding to their peers. Currently, there is a large gap in MOOC literature on whether in-depth discussion occurs and the content of those discussions contribute to KC. It would be interesting to explore this further. Gašević et al.'s (2019) findings provide some insight on how participants who play the role of "brokers" (i.e., strong closeness and betweenness) often focused strongly on a few highly interlinked content-and process related topics. Still, more needs to be explored to better understand how roles and connectivity impact learning outcomes.

The concept of identifying and assigning roles is one approach for measuring knowledge construction in MOOC learning networks. As Wise and Chiu (2011, p. 450) note:

> Online learning conversations often do not realize their potential as sites of rich KC. Typically they remain exercises in listing ideas rather than rich interactions that construct shared understandings […]. One way to increase the likelihood of valuable learning interactions is by assigning roles to students to script their collaboration […]. Roles give students guidance about how to interact with one another productively […], i.e., in ways that promote desired cognitive, metacognitive and socio-cognitive processes […].

Yet, MOOC researchers have not examined the impact of roles on knowledge construction. Wise and Cui (2018a, p. 222) argue that

> prior work has been shown that networks of how people are connected through ideas over time and differences between distributed versus dominated patterns of communication can offer insight into learning processes when these structures are connected back to features of the interactions that generated them. A second explanation arises from the great diversity of topics and purposes found in MOOC discussions (ranging from clarification of course content to logistical questions about assignments and from sharing deep connections with the learning material to pure sociality.

Goggins (2016) and Tawfik et al. (2017) do explore knowledge construction in MOOCs using both SNA and IAM content analysis. Similar to findings from studies of smaller courses, these studies show how higher levels of knowledge construction do not occur in

MOOC discussion forums. Goggins (2016) analyses KC at a group level, however, and does not focus on the role of individual participants in supporting knowledge construction across the whole network. As a result, there is little insight on how interactions among participants influences knowledge construction. Tawfik et al. (2017) show that KC in MOOC discussion forums are dependent on the type of discussion boards (i.e., General Discussion, Study Groups, Weekly Module). They also show that MOOC participants rarely interact with each other and that clusters do not form to create a community of learners, and, as a result there was little engagement in high degrees of co-construction of knowledge. While these findings are significant, it is not clear how a participant's centrality within the MOOC learning network impacts knowledge construction in the discussion forums.

There is some literature that explores how some participants in online learning environments take on roles that influence learning. For example, Haythornthwaite et al. (2016) make an important distinction of different roles students can take in an online learning environment, such as students can:

- Lead discussion, shape arguments and influence the direction of discussion as learner-leaders, e-facilitators, tutors to other students and accomplished fellows who set up working parties to explore a subject in more depth
- Act as knowledge synthesizers who bring together discussion points and reinterpret for others as braiders and patch workers
- Connect to communities, bring knowledge from the online learning community to their local geo-community and vice-versa.

It is the second bullet point that is relevant to this study. Haythornthwaite et al. (2016, p. 255) states:

> Network roles emerge from where actors are positioned in a network, such as for the actor who fills a structural hole or for the most central actor who is the 'network star'. […] Roles also emerge from what actors do in and for a network. Information brokers, technological gurus and others who monitor and bring knowledge into a network help direct it to appropriate receivers as well as select what appears relevant to the network and its learning needs. Individuals may act as sources or disseminators of information and of learning according to the information advice or other contributions to the learning they receive from others – their 'in-degree' learning connection – and what they share with others – their 'out-degree' learning connection.

Considering this, a gap in literature suggests that more is needed to explore the impact roles and connectivity in large learning networks (i.e. xMOOCs) has on knowledge construction. It is still not clear whether the outcomes can be generalized for xMOOCs. When the scale of a learning network is increased, like in MOOCs, does connectivity and roles play an influential role in how knowledge construction occurs? Wise and Chiu (2011), for example, would suggest that some form of intervention is needed and roles need to be assigned to be impactful on knowledge construction. This would be difficult to do in a MOOC. The question then is, might the categories of MOOC participants already identified by literature play a role in knowledge construction? If so, what are their social ties to other learners in the learning network?

## 2.6 Summary of chapter 2

This chapter provides an overview of the literature that informs this study. It began by providing an overview of current literature on MOOCs, focusing on published research concerned with participant engagement, discussion forum participation and learning outcomes. Because the study of MOOCs is relatively new in comparison to other forms of online asynchronous learning, a review of literature was then provided to give an overview of literature on learning, connectivity and networks. The goal was to indicate a current gap in MOOC literature and suggest how the established literature on related areas, such as networked learning, Connectivism, and computer supported collaborative learning, can inform MOOC research. A major gap in MOOC research is, despite its relation to research on networked learning, there is very little empirical research exploring how learning or knowledge construction occurs in a MOOC. This literature review then explores how approaches to social network analysis and the concept of social ties can be used to identify participants' interactions, which might then also provide insight on how knowledge construction occurs. Considering this, the chapter then provides an overview of relevant literature on the subject of knowledge construction in general and knowledge construction in in learning networks. The last section of the chapter discusses how there is a gap in understanding how knowledge is sequentially constructed in MOOC discussion forums and whether any participants or participant roles contribute pivotal posts that impact knowledge construction.

# Chapter 3: Research Design

## 3.1 Introduction

This chapter outlines the methodology and methods of the study, including the theoretical framework design, case studies, data collection, analysis, and limitations. The goal of this study was to add knowledge to the academic community about how connectors may contribute to knowledge construction in online asynchronous learning networks. Particularly, this study looks at two questions: (1) What are the categories of connectors that emerge from participants' social ties in an xMOOC? And (2) How do these connectors support knowledge construction in the discussion forums? To answer these questions, the study adopted a mixed methods case study design using (1) quantitative methods through social network analysis, and (2) qualitative analysis through content analysis using the interaction analysis model.

## 3.2 Epistemological and ontological position

This study adopts a pragmatic worldview outlined by Creswell (2013) and Tashakkori and Teddlie (1998) in that "truth" is "what works" and that the world is both external to the mind and in the mind. As Cherryholmes (1992, p. 14) notes, pragmatists believe that research always occurs in social, historical, political, and other contexts: "Pragmatists take seriously the assumption that we are historically and socially situated, that when we read the world we can never be quite sure if we are reading the 'world' or reading ourselves

[…]". Considering this, the study takes the point of view that an external social world is independent of our minds; however, "truth" or our understanding of that world can be contextually contingent on social phenomena, beliefs and values, and cannot always be determined (Tashakkori and Teddlie, 1998). Furthermore, this study takes the approach that social phenomena are often a part of complex systems that have network effects where emergence properties, such as learning or knowledge construction, occur as the result of interaction among agents within the system (Mitchell, 2009). There may be causal relationships among agents in social complex systems, but it is difficult to "pin them down" or predict emergent behaviour (Goldstein, 1999; Mitchell, 2009; Smith and Conrey, 2007; Tashakkori and Teddlie, 1998).

This study posits that MOOCs are complex systems and that connectors are participants who frequently interact in the discussion forums giving rise to an emergent behaviour (de Waard et al. 2011; Mitchell, 2009; Morrison 2002; Morrison, 2008; Nakano et al., 2015). For example, MOOC participants are free to interact with whomever they want, whenever they want, in the discussion forums, giving rise to a self-organized system where new behaviour emerges as a result of those interactions. This guides the research in how to identify and analyse the emergent property of knowledge construction, which is the result of connectors' interactions in the discussion forums. In this sense, knowledge construction is an emergent phenomenon as a result of the causal relationships among agents (i.e. participants; connectors) in the MOOC learning network (i.e. complex system).

As mentioned in the Introduction, it is assumed that the actions of participants in MOOCs and the consequences of their actions are idiosyncratic to each course. It can also be argued

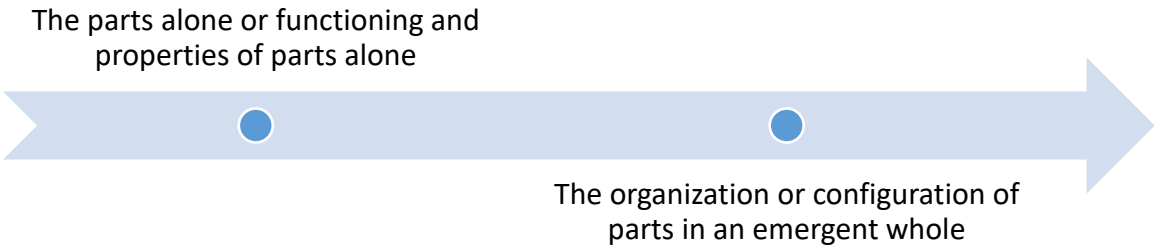
that all MOOCs are social complex systems that have emergent properties (i.e. knowledge construction), nonlinear interactions among components (i.e. participants), feedback loops, network effects, and that they are analysable at multiple levels and contain distributed knowledge. As Morrison (2008) notes, cMOOCs and xMOOCs contain two particular features of complexity theory: (1) connectedness, which requires a distributed knowledge system, and (2) emergence, which suggests that self-organization emerges internally in a system. Emergence, as defined by Goldstein (1999, p. 49),

> refers to the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems. Emergent phenomena are conceptualized as occurring on the macro level, in contrast to the micro-level components and processes out of which they arise.

Goldstein adds that emergent phenomena share certain common properties in that emergents (1) are not previously observed in the complex system that is being observed, (2) appear as integrated wholes at the macro level of complex systems and (3) evolve and tend to maintain some sense of identity over time. Goldstein also argues that is it better to consider emergent phenomena as a continuum, focusing on across-system organization "rather than on the part or properties of parts alone" (Figure 5).

**Figure 5**

*Continuum of emergence explanations*




In this sense, both categories of MOOCs are autocatalytic, in that a system of networked learners can evolve itself, from within. Knowledge construction, for example, could be an emergent phenomenon at the macro level of a MOOC, which is analysable through agent-based modelling, the observation of emergent patterns from the interaction of a large number of autonomous agents, at the micro level (Smith and Conrey, 2007). Morrison (2008, p. 28) also notes that complexity theory suggests

> that the conventional units of analysis in educational research (e.g. individual, institutions, communities and system) should merge, so that the unit of analysis becomes a web or ecosystem, focused on, and arising from, a specific topic or centre of interest.

Therefore, this study analyses MOOCs as social complex systems where the emergence of knowledge construction is dependent on the participants, their connectivity, and their interaction. As Smith and Conrey (2006, p. 87) note,

> Most social and psychological phenomena – from attitude polarization in group discussion, to escalation of intergroup conflicts, to stereotype formation, to large-

> scale social trends in aggression or unhealthy behaviour – occur not as the result of explicit choices by isolated individuals, but rather as the result of repeated interactions between multiple individuals over time.

## 3.3 Research methodology

Identifying and predicting emergent phenomena, such as knowledge construction, in social complex systems is difficult to do. A constructive way of addressing this issue is to adopt a pragmatic paradigm, "where the primary attention is given to the research question asked, as opposed to holding a particular allegiance to a philosophy or methodology when carrying out [MOOC] research" (Eynon et al. 2016, p. 3). According to Eynon et al. (2016, p. 3), the pragmatic paradigm includes the following characteristics:

> (1) both qualitative and quantitative methods, (2) deductive and inductive logic (3) objective and subjective viewpoints, (4) the important role of values when interpreting results, (5) the acceptance of choosing explanations of the research that produce desired outcomes, and (6) the exploration of causal linkages, but under the acknowledgement that while an attempt will be made to make the linkages, they may not be defined precisely as data can lead to a number of explanations.

Considering this, a mixed methods approach for this study is appropriate because it recognizes that "truth" about an emergent phenomenon (i.e. knowledge construction) in MOOCs or our understanding of that truth is contextually contingent on participants' connectivity and interactions. The "truth" about what type of connectors emerge from social ties within a MOOC and how they support knowledge construction may share

common features with other social complex systems; however, it cannot always be determined or predicted. What can be observed and identified in MOOCs as complex systems are the type of connections among participants, such as centrality and betweenness. These measurable "truths" can then lead to a further understanding of possible emergent phenomena, such as knowledge construction.

As a mixed-methods approach, this study adopts Gunawardena et al. (2016) call for combining SNA and IAM to analyse the social construction of knowledge in online discussion forums has been used. SNA is used as a process that assists, not substitutes, IAM to help identify connectors and their social ties (see *Figure 4*). Eynon et al.'s (2016) six characteristics guide this research in how the qualitative (IAM) and quantitative (SNA) methods are used to provide objective and subjective views of how MOOC participants connect, interact, and construct knowledge, and by exploring the causal linkages of connectivity in a learning network with the emergence of participants' roles in constructing knowledge.

Eynon et al. (2016) note that mixed methods in MOOC research gives equal value to all methods to research how people learn and interact in MOOCs. The aim of this study explores three levels of data, as outlined by Eynon et al. (2016): (1) structural descriptions (i.e. patterns of interactions), (2) thin descriptions, which note the content of the interaction, and (3) thick descriptions, to provide context and convey the meaning of the events by the participants.

### 3.3.1 Mixed Methods Case Study Design

This study employs a mixed methods case study design, as proposed by Cresswell and Clark (2018) in which the quantitative and qualitative data collection, results, and integration are used to provide in-depth evidence for two iterations of a case. As suggested by Creswell and Clark (2018), a case may be "an individual, and organization, or an activity that is bounded by certain criteria," and the complex mixed methods design is consitent in that it "focuses on developing a detailed understanding of a case (or multiple cases) through gathering diverse sources of data" from multiple sources of quantiataive and qualitative data. Additionally, they argue that researchers are drawn to understanding and comparing the complexity within and between cases using mixed methods data.

For the purpose of this research, a case study "is an empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (Yin, 2014, p. 16). Adopting a case study design provides "a way of investigating connections, patterns and context, and reflecting on the bigger picture as well as on the detail" (Atkins and Wallace, 2012). This study involves two iterations of a case (i.e. two separate offerings of the same MOOC course) where the emergent phenomena of knowledge construction occurs in a complex system as the result of MOOC participants connecting and interacting with each other in discussion forum threads. The case study design is based on what Ridder (2017) identifies as a social construction of reality, where the aim is to research "specific actions, in specific places, at specific times" to facilitate an

understanding of a research issue. In order to study the emergent phenomena of knowledge construction, this study developed a set of criteria to assist with identifying (1) the complex system, (2) the size of the complex system, (3) timeframe of when the emergent phenomena occur, (4) the environment and the rules it governs, and (4) the participants to be studied. Data was collected from two offerings of the same xMOOC course, where the case choice is based on the following criteria:

Specific action:

- xMOOC participants engage each other through online asynchronous discourse, and
- Knowledge construction emerges as the result of participants' engagement.

Specific place:

- The MOOC provider is edX and the courses are delivered on the same learning management systems, and
- Participant engagement occurs in the edX discussion forums

Specific time:

- The duration for each course is 6 weeks, and
- Discourse occurs asynchronously over the 6 week period.

The title and times the course was offered are:

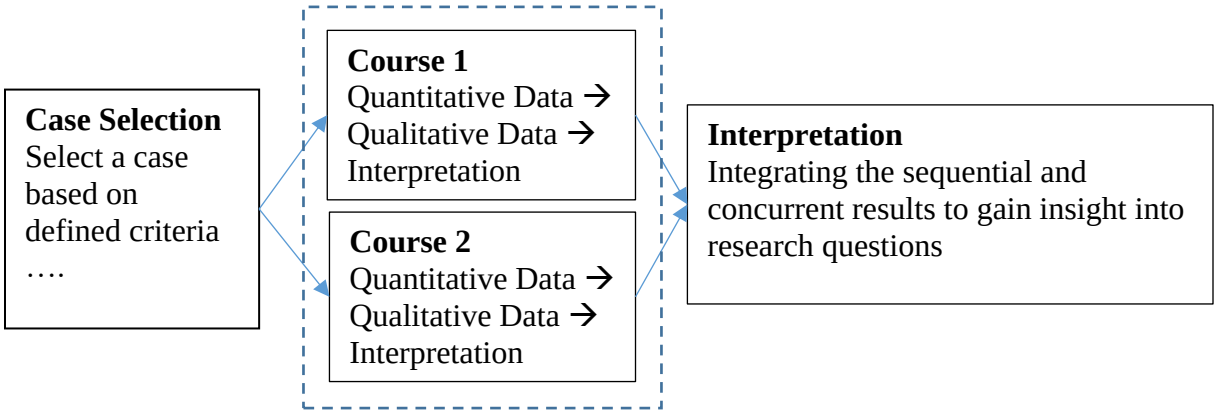
- *English for Doing Business in Asia – Speaking* (Course 1) offered through edX September 2014, and
- *English for Doing Business in Asia – Speaking* (Course 2) offered through edX June 2016.

xMOOCs are usually organized by weekly modules, which consists of weekly discussion forum activities based on each module topic.

The intent of a mixed methods case study design is to develop an enhanced description and analysis of a case through the use of both quatitative and qualitative data. By analysing two iterations of the same case, the study is able to provide "thick" descriptions and a "holistic" view of the case (Ridder, 2017). The case was identified at the start of the study based on the defined criteria. *Figure 6* illustrates the process of the mixed methods case study apporach.

**Figure 6**

*Diagram of a Comparative Mixed Methods Case Study adapted from (Creswell and Clark, 2018)*



### 3.3.2 Sequential explanatory design approach

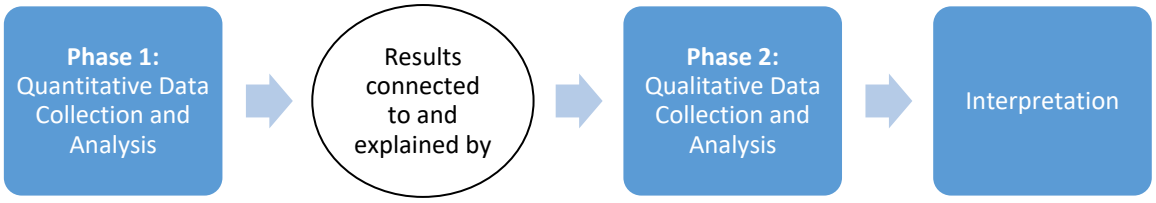
As Creswell and Clark (2018) note, sequential approaches have used various design names: sequential model, sequential triangulation, a qualitative follow-up approach, and iteration design. For the purpose of this research, a sequential explanatory design approach is used:

> The explanatory sequential design is a mixed methods design in which the researcher begins by conducting a quantitative phase and follows up on specific results with a subsequent qualitative phase to explain the quantitative results. The qualitative phase is implemented for the purpose of explaining the initial results in more depth, and the same of the design – explanatory – reflects how the qualitative data help explain the quantitative result (Creswell and Clark, 2018, p. 77).

In other words, the purpose is to use the qualitative to explain and interpret the quantitative. The method consists of two distinct phases. *Figure 7* illustrates the explanatory sequential design.

**Figure 7**

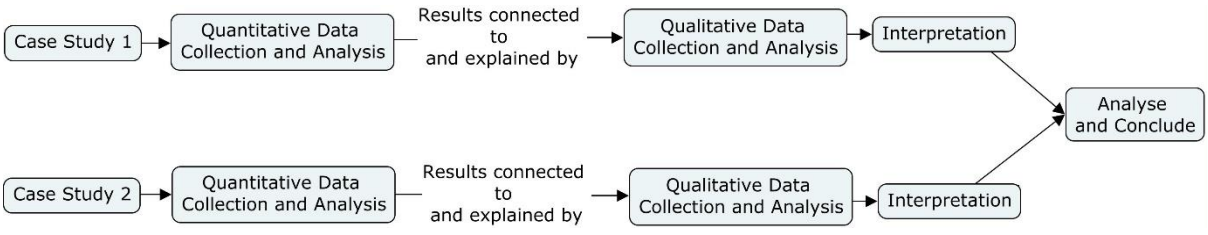
*Sequential explanatory mixed methods design, adapted from Creswell and Clark (2018)*



In the first phase of this study, quantitative data (participants' ties in a social network) was collected and a social network analysis was used to identify highly connected participants within each case. The quantitative results were then used to guide purposeful sampling of qualitative data, the content within the discussion forums. Next, this study connects to a second phase "by identifying specific quantitative results that call for additional explanation and using these results to guide the development of the qualitative strand" (Creswell and Clark 2018, p. 139). The qualitative data (discussion forum content) was collected in the second phase and interaction analyses (Gunawardena et al., 2016) was conducted by coding for meaning using the IAM to elaborate on the quantitative results from the first phase. Because this study uses a mixed methods case study design, sequential explanatory mixed methods was applied for each iteration of the case, and a third phase was added to collate the interpretations for a final analysis (*Figure 8*). The rationale for this approach is that it considers multiple levels for analysis within a social complex system: the quantitative data being agent-based and the subsequent analysis being a qualitative analysis of the emergent phenomenon.

**Figure 8**

*Sequential explanatory mixed method case study design, adapted from Creswell and Clark (2018)*



## 3.4 Phase 1: Quantitative Data Collection and Analysis

### 3.4.1 Collection of discussion forum data

This study collected data for analysis from two edX courses. For each course, aggregated forum data (i.e. thread title, user id, content) generated in a course in the edX platform was collected, anonymized and analysed. This consisted of aggregated discussion forum data from each course. For the first iteration of the case (Course 1), 1,318 postings were analysed, posted by 540 different participants. For the second iteration of the case, 2, 597 postings were analysed, posted by 165 different participants. *Figure 9* shows an example of a discussion forum thread in the edX learning management system. The aggregated discussion forum data from each course was downloaded and exported into separate Excel files. Each file contains anonymized user's ids (user_id), timestamps for their posting (CreateTime), content within the threads (Body), and discussion forum thread titles (Title) threads. *Figure 10* shows an example screenshot of the excel file.

**Figure 9**

*Screenshot of a discussion thread in the edX learning management system.*

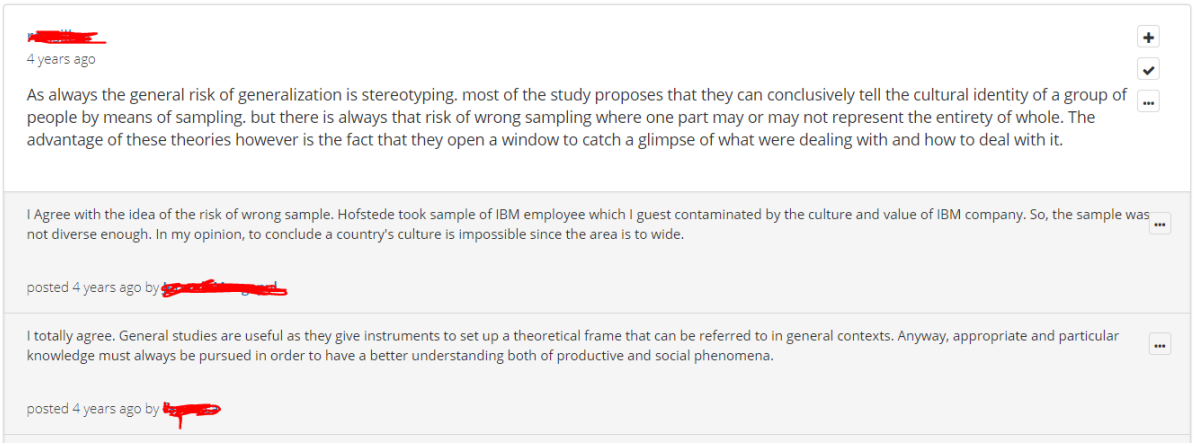



**Figure 10**

*Screenshot of discussion forum data in excel format*

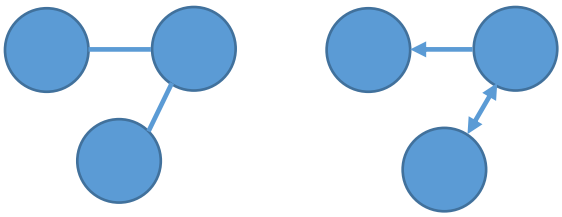
| | | | |
|---|---|---|---|
| 2014-10-01T02:12:08.806Z | CRITICALLY THINKING ABOUT HOF | Think about your experience with other cultures. **How adequate are Hoftsedeâ€™s cultural dimensions theory and/or the GLOBE study in prov | c302fe7fb43fdecd68575674c9826d4b |
| 2014-10-01T06:38:21.900Z | N/A | As always the general risk of generalization is stereotyping. most of the study proposes that they can conclusively tell the cultural identity of a gr | 830776d8b589db3e78f4fd4927b0b6a3 |
| 2014-10-03T10:52:32.917Z | N/A | I Agree with the idea of the risk of wrong sample. Hofstede took sample of IBM employee which I guest contaminated by the culture and value o | d69dc2df960fbc32b0d59df5506418c6 |
| 2014-10-03T12:33:26.076Z | N/A | I totally agree. General studies are useful as they give instruments to set up a theoretical frame that can be referred to in general contexts. Anyw | a23ba7552ce83d69edb4aeb627aa898e |
| 2014-10-03T15:11:12.389Z | N/A | I too agree. But I also see that some of the generalizations are very close to home. | c6480b72165426facac1453b42741a28 |
| 2014-10-03T15:38:33.353Z | N/A | I totally agree too. Generalizing can provide a good starting point. It certaintly gives you a view of the place you are going to and the things you r | 74bcc9bf12cc72ecba799ba594827e65 |
| 2014-10-04T11:38:42.673Z | N/A | I totally agree. But keep in mind that the perfect sampling is almost impossible to do. So, I think, though these therories may not reflect the truth | 7cb067919335e5b90dd9fffb27428391 |

For each iteration of the case, all identifying information was removed and participant user ids were randomized. For example, a participant's name was randomized to the *user id 5e926824b3f3fe8a7d8a0387e4d3db84*. For clarity and simplicity of reporting of the findings in this research, all user IDs were shortened to the first six characters. Therefore, *user id 5e926824b3f3fe8a7d8a0387e4d3db84* is *Participant 5e9268*. Discussion thread title ids were also randomized, and thread IDs were shortened to seven characters. For example, the *discussion thread ID 56cbaee522a8fb051f000632* was shortened to *thread 56cbaee*.

### 3.4.2 Social Network Analysis (SNA)

There are two types of SNA networks: directed and undirected. Directed SNA networks represent relational phenomena (for example, "gives advice to" and "disagrees with") and directed relations can be reciprocated (Borgatti et al. 2013). For undirected SNA networks, direction does not occur (for example, "John was seen with Jane"). *Figure 11* illustrates the differences between directed and undirected SNA networks. Because MOOC discussion forum interactions among participants is complex, assumptions are made for analysis: each posted message in the forum is directed to all participants, and, consequently, interaction within the discussion forum includes all participants (Dowell et al., 2015; Laghos and Zaphiris, 2006; Rabbany et al., 2014). Discussion forum posts are assumed to be directed to all MOOC participants that replied, and replies are directed to all existing participants in a specific discussion thread.

**Figure 11**
*Undirected graph and directed graph*



To carry out a social network analysis, a two-mode matrix was created from the aggregated forum data for each iteration of the case. A two-mode matrix is a table of relations, where, typically, "rows represent individual actors and columns represent events, organizations, or some other identity category" (Carolan, 2014, p. 61). Two-mode matrices are known as affiliation networks (Borgatti and Everett, 1997). Affiliation networks reflect the connections of two different sets of actors. For the purpose of this study, the rows represent participants, and the columns represent the discussion thread topic. Like Moser et al. (2013, p. 552), network ties are defined as the "simultaneous presence of postings at the same topic". *Table 2* illustrates an example of a two-mode matrix.

**Table 2**

*Example of a two-mode matrix*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| A1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| A2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| A3 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| A4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

The two-mode matrix for this research indicates the number of times an individual MOOC participant (row) posted in a particular forum thread (column). For Course 1, the columns are the 60 discussion forum threads, and the rows are the 540 MOOC participants. For Course 2, the columns are 23 discussion forum threads, and the rows are the 165 MOOC

participants. For example, *Table 3* is a sample of a two-mode matrix for Course 1, showing that *Participant P1 posted* in the *thread F1* three times, but did not post once in *thread F3*.

**Table 3**

*Two-mode matrix of EBA101x*

| Participant | Discussion Forum Thread | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 |
| P1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| P2 | 1 | 1 | 1 | 2 | 2 | 0 | 1 | 0 | 0 |
| P3 | 1 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 2 |
| P4 | 1 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 1 |
| P5 | 3 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 1 |
| P6 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| P7 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

The two-mode matrices were then converted into a one-mode matrices to identify how pairs of participants are tied together and share affiliations through their participation in the discussion forum. For this study, the one-mode matrix consists of rows and columns that represent MOOC participants that have contributed to discussion threads. The matrix cell values indicate the number of times a participant has contributed to the same discussion thread as another participant. *Table 4* shows an example of the one-mode matrix. For example, *participant P7* is tied to *participants P1*, *P2*, and *P3* three times each. That is *participant P7* is contributing to the same three discussion threads that *participant*

*P1* contributed to, and the same three threads that *participant P2* contributed to, and the same three threads that *participant P3* contributed to. This suggests ties inferred from the two-mode matrix. As Borgetti et al. (2013, p. 30) note, "we need to interpret the co-membership tie as, at best, a potential for interaction". Or, as they suggest with similar phenomena, "we may see co-attendance or co-membership as a potential for activation" (2013, p. 31). In relation to this study, co-contribution to a discussion thread has the potential for interaction, or ties, among participants. Again, as previously stated and as other studies suggest, MOOC discussion forum posts are treated as an interaction with all other participants in the same thread (Dowell et al., 2015; Laghos and Zaphiris, 2006; Rabbany et al., 2014).

**Table 4**

*One-mode matrix of EBA101x 2014*

| Participant | Participant | | | | | | |
|---|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| P1 | -- | 2 | 1 | 2 | 1 | 3 | 1 |
| P2 | 2 | -- | 2 | 2 | 1 | 3 | 1 |
| P3 | 1 | 2 | -- | 1 | 1 | 3 | 1 |
| P4 | 2 | 2 | 1 | -- | 1 | 3 | 1 |
| P5 | 1 | 1 | 1 | 1 | -- | 3 | 1 |
| P6 | 1 | 2 | 2 | 1 | 1 | -- | 1 |
| P7 | 3 | 3 | 3 | 3 | 3 | 9 | -- |

Wellman (1988, p. 26) notes that the forms of social relations greatly determine their contents:

> A basic strength of the whole network approach is that it permits simultaneous views of the social system as a whole and of the parts that make up the system. Analysts are therefore able to trace lateral and vertical flows of information, identify

sources and targets, and detect structural; constraints operating on flows of resources.

As Kellogg (2014) notes, MOOCs provide a unique opportunity for better understanding of networked learning.

### 3.4.3 Degree, Betweenness and Closeness Centrality Coefficients

To address the first research question (What are the categories of connectors that emerge from participants' social ties in an xMOOC?), social network analysis was used to identify degree, betweenness, and closeness centrality coefficients for each case. Centrality indices, similar to ones adopted by Moser et al. (2013) in their study of MOOCs, are used to compute the centrality of forum participants in the network. This includes degree centrality coefficient, betweenness centrality coefficient, and closeness centrality coefficient. As Moser et al. (2013, p. 23) suggest, "centrality is a critical concept which has led to an increasingly finely tuned set of centrality measures to cater for specific theoretical aims". Centrality provides information about participants' interaction with others within a network (De Laat et al. 2007). "Centrality captures the extent to which a focal actor occupies an important position of prestige and visibility" (Carolan, 2014, p. 154). For this study, the purpose is to identify connectors who may be pivotal in knowledge construction within the MOOC discussion forums.

To do this, this study uses SNA to identify the different centrality measurements. *Degree centrality* is the measurement of the number of ties a participant has to other participants

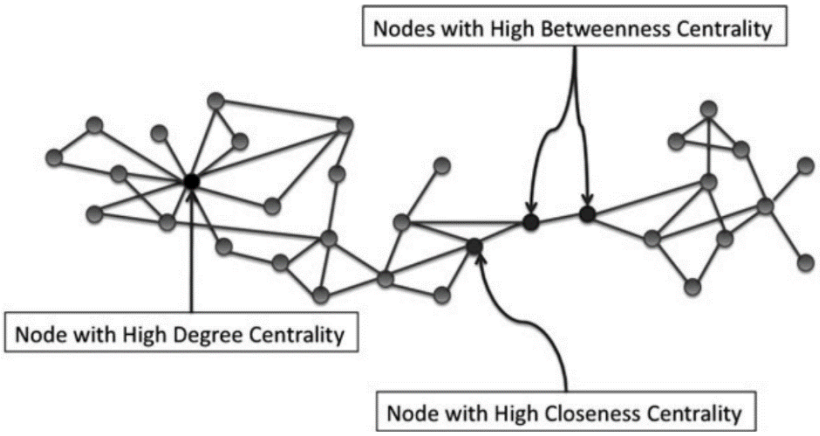
within the MOOC learning network. As mentioned earlier, participants are considered to have a tie with another participant through the association of posting in the same discussion thread. The more ties a participant has to other participants in the MOOC learning network (the entire discussion forum), the higher their degree centrality measurement is. *Betweenness centrality* "captures how actors control or mediate the relations between pairs of actors that are not directly connected" (Carolan, 2014, p. 157) and "considers the advantages of actors who lie between pathways connecting other pairs" (Buraphadeja, 2010, p. 82) or clusters of actors in the MOOC learning network. For example, a MOOC participant may be able to connect and share ideas in one discussion thread to another thread. In this sense, they are the broker of information between the two discussion threads. *Closeness centrality* "considers the path lengths between a pair of actors as a form of power; actors who could reach others in short path lengths (i.e., closer to other actors) have an advantage over their fellow actors in gaining resources" (Buraphadeja, 2010, p. 82). For example, if a participant were to post in most of the MOOC discussion threads, other participants would not need to participant in many threads to interact with them. In contrast, if a participant posts only once in a thread which they created and no one responds, they would have a closeness centrality measurement of 0, meaning that there is no path to connect to that participant.

In summary, participants with: (1) high degree centrality suggests they are at the centre of the network as a whole, or of a local cluster in the network; (2) high betweenness suggests the participant is a key "mediator" in linking other participants; and (3) high closeness suggests a participant is closer to other participants, "based on the geodesic distance"

(Oshima et al. 2012). *Figure 12* adapted from Oshima et al. (2012), illustrates what degree centrality coefficient, betweenness centrality coefficient, and the closeness coefficient may look like in a sociogram. In this example, the node with the most ties to other nodes has the highest degree centrality measurement; the two nodes that connect clusters of nodes have the highest betweenness centrality measurements and the node that has the shortest path to other pairs or clusters of nodes has the highest closeness measurement.

**Figure 12**

*Three centralities in a network from Oshima et al., 2012*




Degree, betweenness and closeness centrality coefficients were calculated by importing the one-mode matrix in the social network analysis tool, UCINET. Degree centrality coefficient measurements are relevant to this student because they identify the number of participants tied to a specific participant. Jiang et al. (2014, p. 57) highlight this in their study of MOOCs: "In the context of our MOOC network, this [degree centrality] represents the number of other learners to which one is tied through participation in discussion forum

threads. Those with high degree have greater levels of participation in a variety of threads that put them in contact with other learners". Their study also notes how betweenness centrality measures the extent to which a participant bridges other participants: "Nodes with high betweenness have been described as having some degree of control over the communication of others as well as greater opportunities to exert interpersonal influence over others" (Jiang et al. 2014, p. 57). Similar to Jiang et al (2014) study, participants with high betweenness in each case "participate in discussions in such a way to learners across multiple forum threads" (Jiang et al. 2014, p. 57). This study also adopts Dowell et al. (2015, p. 253) interpretation that high closeness centrality suggests a learner is in "the middle of what is happening on the forum".

The same methods and SNA tools were used to analyse the data from Course 2.

## 3.5 Explanation of how quantitative results connect to qualitative

The next step of the study was to connect the quantitative analysis to the qualitative analysis. As mentioned, the first phase of this study was to identify participants and their relational ties within a network. Gunawardena et al. (2016, p. 40) point out that "relational ties […] between students are interaction channels for transfer, or 'flow,' of information through postings in online discussion forums. Social network diagrams can depict student roles as lasting patterns of interactions among students". According to Edwards (2010, p. 6),

> formal SNA has developed a particular interest in the kinds of things that 'flow' through the network and the ways in which the (measurable) structural properties

> of the network affect how they flow. Key topics of inquiry include, for example, the flow and exchange of resources, trade flows between countries, the flow of information and ideas, the diffusion of innovation in organizations, the flow of disease and influence, and the flow of social support.

Using the network maps and measures as a guide, they then select actors for further qualitative research (e.g. interviews) on the basis of their structural position in the network. Thus, SNA identifies and highlights connectors and their position in a MOOC, allowing for further qualitative research to occur to determine how they construct knowledge. Participants who have high degree centrality, high betweenness centrality, and high closeness centrality or a combination of these were identified as 'connectors'.

To identify potential connectors, participants with high degree, betweenness and closeness centralities were placed in three corresponding tables, one for degree centrality, one for betweenness centrality, and one for closeness centrality. The purpose of this step is to identify participants that may have pivotal roles in the discussion threads and influence knowledge construction. Participants with high centrality scores are considered potential connectors and the content from their contribution in the discussion threads will be coded for meaning using the IAM as suggested by Gunawardena et al. (2016). In addition, a comparison across the tables is then made to identify whether any participants scored high in more than one table. For example, of concern was whether a participant with high degree centrality also scored high betweenness centrality or high closeness centrality; or, for example, whether a participant with high betweenness centrality scored high in degree centrality and/or closeness centrality. This would inform the study on whether a different

type of connector exists, and potentially have pivotal roles in the discussion forum. Any connectors identified across the tables will also have their content from their contribution in the discussion threads will be coded for meaning using the IAM as suggested by Gunawardena et al. (2016).

*Figure* 4 outlines the process of using the discussion forum data for the SNA to identify and highlight what data to analyse in phase 2: qualitative analysis.

## 3.6 Phase 2: Qualitative Collection and Analysis

The SNA creates a finite set of participants (connectors) and their relational ties identified in each iteration of each case and the interactions among them in the discussion forum (Gunawardena et al., 2016). Discussion forum content was collected from the EdX forums based on this finite set and content analyses was conducted by coding for meaning using the IAM to elaborate on the quantitative results from Phase 1.

### 3.6.1 Interaction Analysis Model

To address the second research question (How do these connectors support knowledge construction in the discussion forums?), an interaction analysis of the transcript of conversations between connectors and other MOOC participants in the aggregated forum data was conducted using qualitative coding for meaning using the IAM as suggested by Gunawardena et al. (2016). Results from IAM content analysis was used to examine the sequences of interaction among connectors and other participants that occurred in the

discussion forums to identify pivotal posts and identify whether connectors and whether and how knowledge was constructed as a result of a connector's interaction with other MOOC participants (Gunawardena et al., 1997; Gunawardena et al., 2016; Wise and Chiu, 2011). Wise and Chiu (2011, p. 448) note that:

> Viewing KC as an interdependent process and a cumulative group effort, an individual's progress through the phases depends on and influences other group members, stimulating them to proceed through the phases more-or-less together. Transitions between the phases can thus be viewed as initiated by a 'pivotal post:' a contribution by a student (or the instructor) which changes the mode of discussion from one phase to another.

This study follows the same assumption as outlined in their study that "pivotal posts and their role in online discussions resonates with other recent work in the CSCL community to define and identify pivotal moments in collaboration" (Wise and Chiu, 2011, p. 448). *Table 5* illustrates the IAM Phases that were used to code the transcripts. For example, discussion transcripts of connectors' conversations were analysed to identify whether and how different IAM phases occurred and whether a connector was tied to those interactions.

**Table 5**

*The IAM developed by Gunawardena et al., (1997).*

| PHASE I: SHARING/COMPARING OF INFORMATION. |
| --- |
| Stage one operations include: |
| A. A statement of observation or opinion |
| B. A statement of agreement from one or more other participants |

| |
|---|
| C. Corroborating examples provided by one or more participants<br><br>D. Asking and answering questions to clarify details of statements<br><br>E. Definition, description, or identification of a problem |
| PHASE II: THE DISCOVERY AND EXPLORATION OF DISSONANCE OR INCONSISTENCY AMONG IDEAS, CONCEPTS OR STATEMENTS.<br><br>Operations which occur at this stage include:<br><br>A. Identifying and stating areas of disagreement<br><br>B. Asking and answering questions to clarify the source and extent of disagreement<br><br>C. Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view |
| PHASE III: NEGOTIATION OF MEANING/CO-CONSTRUCTION OF KNOWLEDGE<br><br>A. Negotiation or clarification of the meaning of terms<br><br>B. Negotiation of the relative weight to be assigned to types of argument<br><br>C. Identification of areas of agreement or overlap among conflicting concepts<br><br>D. Proposal and negotiation of new statements embodying compromise, co-construction<br><br>E. Proposal of integrating or accommodating metaphors or analogies |
| PHASE IV: TESTING AND MODIFICATION OF PROPOSED SYNTHESIS OR CO-CONSTRUCTION |

| |
|---|
| A. Testing the proposed synthesis against "received fact" as shared by the participants and/or their culture<br>B. Testing against existing cognitive schema<br>C. Testing against personal experience<br>D. Testing against formal data collected<br>E. Testing against contradictory testimony in the literature |
| PHASE V: AGREEMENT STATEMENT(S)/APPLICATIONS OF NEWLY-CONSTRUCTED MEANING<br>A. Summarization of agreement(s)<br>B. Applications of new knowledge<br>C. Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction |

It should be noted that the IAM was developed specifically for smaller online courses where more in depth discussions occur. As mentioned in the Literature Review, there is yet to be any empirical evidence that the same in depth discussion occurs in MOOC discussion forums. Goggins (2016) and Tawfik et al. (2017) do explore knowledge construction in MOOCs using IAM content analysis, and their findings show how higher levels of knowledge construction do not occur in MOOC discussion forums. A goal of this study is to add to the literature by exploring how the IAM can be used for MOOC discussion forums. The following section explains how KC pattern sequences were analysed in this study.

### 3.6.2 KC pattern sequences

As suggested, knowledge creation does not occur in isolation. Considering this, knowledge construction is dependent on the interrelation of a sequence of posts among MOOC participants in the discussion forum. Knowledge construction is the result of collaborative dialogue. Therefore, in order to understand whether a connector contributes to the collaborative dialogue, it is important to not only analyse their isolated discussion forum messages using the IAM content analysis. It is also impotent to analyse the sequence of messages that surround their post. That is, identifying which IAM phase a connectors forum post belongs to does not reveal whether they are contributing to knowledge creation in the learning network.

To identify whether connectors were pivotal in influencing knowledge creation in the discussion threads, the study mapped IAM phases of sequences of posts by participants who contributed before and after the connector. As Wise and Chiu (2011, p. 457) note:

> A strict chronological sequence places each post on a time line, strictly according to its time of creation and irrespective of its references and relationships to other posts. In contrast, a semantic chronological sequence tracks the discussion of shared ideas by using the thread structure as the primary organizer and by using time to order same level posts.

Wise and Chiu (2011, p. 448) suggest that groups in computer mediated communication construct knowledge through a specific sequence of KC phases:

> Viewing KC as an interdependent process and a cumulative group effort, an individual's progress through the phases depends on and influences other group members, stimulating them to proceed through the phases more-or-less together. Transitions between the phases can thus be viewed as initiated by a "pivotal post:" a contribution by a student (or the instructor) which changes the mode of discussion from one phase to another. Our notion of pivotal posts and their role in online discussions resonates with other recent work in the CSCL community to define and identify pivotal moments in collaboration.

Once a connector's post was identified, IAM content analysis was conducted on previous and following posts. Mapping KC patterns would look like the following 1112**3** → 3311, where the bold number represents the connector's IAM Phase score. The KC patterns were then analysed and categorized under theoretical predicted KC patterns (Gunawardena et al., 1997; Wise and Chiu, 2011). The possible KC patterns are:

- 1a: Strictly progressive segments for each KC phase
- 1b: Progressive and regressive segments for each KC phase
- 2a: Strictly progressive segments, but some KC phases skipped
- 2b: Progressive and regressive segments, but some KC phases skipped
- 3: Mixed KC phase segments
- 4: No distinct segments of KC.

Of course, caution is needed when using a KC framework for xMOOC research. As mentioned earlier, there is a difference between the outcome of discussion forum activity in small online courses often found in higher education and xMOOCs. Smaller courses are

more likely to have more in depth discussions among students as they are members of a smaller community and it is easier for them to know each other. Goggins (2016) shows that a community of learning does not occur in xMOOCs, lessoning the likelihood that KC will occur in the discussion forums. And, as Tawfik et al. (2017, p. 424) note,

> this [community of learners] may be exacerbated in xMOOCs, which attract large number of participants from diverse settings, and suffer from high levels of attrition. That is, if learners only interact intermittently and for short periods, they may not establish the peer networks requisite for co-construction and negotiation of meaning.

### 3.6.3 Inter-rater reliability

Strijbos, Martens, Prins, and Jochems (2006) note that CSCL research requires rigorous methods to ensure reliability, which includes choosing appropriate units of analysis to warrant "accuracy" of conclusions: reliability "does not only apply to assigning codes, but in those instances where the granularity of the unit of analysis is very small, reliability also applies to determining those 'units'" (p. 6). Considering Strijbos et al.'s (2006) four contextual constraints, (1) the object of study, (2) the nature of communication, (3) the collaboration setting, and (4) the technological communication tool, it was determined that unit of analysis be defined as individual messages posted in the forum by the MOOC participants (Strijbos et al., 2006). Since there was only one coder, the IAM content analysis was conducted twice over a one-month period to test coding reliability.

## 3.7 Interpret the case study results

Based on the SNA and IAM content analysis of the discussion forums results from both iterations of the case, this study integrates the sequential and concurrent results to gain insight into the research questions. This is done by exploring patterns of similarity or differences among both the SNA and IAM content analysis results of each iteration of the case. This is somewhat similar to multiple case study design. As Yin (2014, p. 57) argues,

> the logic underlying the use of multiple-case studies is the same. Each case must be carefully selected so that it either (a) predicts similar results (a literal replication) or (b) predicts contrasting results but for anticipatable reasons (a theoretical replication).

Because this study is based on the presumption that a learning network will include agents that have different levels of centrality measures, it can be assumed that literal replication will occur. For example, theoretically, it is possible that each iteration of the case has participants who have high degree centrality and / or betweenness centrality. Additionally, this study is also based on the theoretical presumption that participants with high centrality scores frequently contribute to the discussion forums, potentially contributing to knowledge construction and collaborative dialogue. Identifying patterns of similarities or differences between the two iterations of the case will assist in building a proposition that explains what categories of connectors appear in a MOOC learning network and how they support knowledge construction in the discussion forums.

## 3.8 Summary

This chapter outlines the methodology and methods of the study, including the theoretical framework design, case study, data collection, analysis, and limitations. The chapter begins by describing the methodology, explaining that a comparative mixed methods case study design fits best the purpose of the study because identifying and predicting emergent phenomena, such as knowledge construction, in social complex systems is difficult to do. Therefore, adopting a pragmatic approach, where both qualitative and quantitative methods are applied, because it is able to recognize and analyse an emergent phenomenon (i.e. knowledge construction) in a social complex system (i.e. xMOOC discussion forum). The following sections of this chapter describe how the research methodology was designed and what tools and method were used to collect and analyse the data. This includes defining and identifying the case and how this study adopts a sequential explanatory design approach to the two iterations of the case. This includes two phases: (1) quantitative data collection and analysis (i.e. SNA) and (2) qualitative data and collection and analysis (i.e. IAM content analysis). Because this is a case study that includes two iterations of the same case, these two phases are carried out for each individual iteration followed by a cross-analysis and conclusion. A description of how SNA and the IAM content analysis are provided, with an explanation of how the SNA quantitative data connect to the qualitative data. This includes identifying relational ties in the learning network, and explaining how those relational ties help identify participants who may have pivotal roles in the KC patterns. The chapter concludes by explaining how this study interprets the case study results.

# Chapter 4: Results

## 4.1 Introduction

The chapter is divided into three parts. The first section discusses the results of the SNA findings and analysis of both iterations of the case (Course 1 and 2) to address the first research question in identifying categories of connectors that emerge from participants' social ties in an xMOOC. Part two discusses the results of the content analysis using the interaction analysis model (IAM) and the identifies the KC patterns for connecters to address the second research question. The final section reports on the commonalities and differences across the two courses.

To summarize, six categories of connectors who potentially have pivotal roles in knowledge construction are identified. The categories of connectors are: (1) high degree, betweenness and closeness centralities; (2) high degree and closeness centrality; (3) high degree and betweenness centrality; (4) high betweenness and closeness centrality; (5) high degree centrality; and (6) high betweenness centrality. The IAM content analysis of the identified connectors' contributions to discussion forums indicate that relational ties in the learning network do not guarantee or have little to no impact on knowledge construction. There does not seem to be any correlation between high centrality scores and a connector's influence on knowledge construction. Furthermore, findings suggest that connections, or the presence of connectors, are not "good" enough to enable learning to occur and that knowledge construction as defined by Gunawardena et al. (1997) within the MOOC

learning networks is limited. The presence of connectors does not automatically influence participants' understanding or development of new knowledge as a result of their interactions in the discussion forum.

## 4.2 Phase 1: SNA findings and analysis

Participants are not viewed as independent units in the network, and their actions and contributions to the discussion forums are viewed as interdependent on others' contributions (Gunawardena et al., 2016). This is consistent with complexity theory which posits that emergence occurs as the result of a system's components interacting (Mitchell, 2009). For this study, participants are the components, and their relational ties are the emergence as a result of interaction in the discussion forums. By conducting a social network analysis of the discussion forums, it becomes possible to identify the relational ties that emerge from that interdependence and identify participants who are central within the learning network. As mentioned earlier, to address the first research question (What are the categories of connectors that emerge from participants' social ties in an xMOOC?), social network analysis was used to identify degree, betweenness, and closeness centralities. This makes it possible to identify categories of connectors that emerge as a result of their relational ties in the xMOOC learning network. A participant with high centrality measures in the learning network is considered to be a connecter and is in an influential position for knowledge transfer, for example. The categories of connectors that emerged from the social network analysis are: (1) high degree, betweenness and closeness

centralities; (2) high degree and closeness centrality; (3) high degree and betweenness centrality; (4) high betweenness and closeness centrality; (5) high degree centrality; and (6) high betweenness centrality (Table 6).

**Table 6**

*Categories and numbers of connectors identified in both iterations of the case*

| Identified Connector | degree, betweenness and closeness | degree and closeness | degree and betweenness | betweenness and closeness | degree | betweenness |
|---|---|---|---|---|---|---|
| **Iteration 1** | 0 | 2 | 1 | 2 | 1 | 1 |
| **Iteration 2** | 2 | 0 | 0 | 2 | 2 | 0 |
| **Total** | 2 | 2 | 1 | 4 | 3 | 1 |

To identify these connectors, discussion forum data was collected and was transformed into a single-mode data, or a participant-by-participant matrix. This matrix was then imported into UCINET to calculate the degree, betweenness, and closeness centralities. Data from the first iteration of the case (Course 1) includes 540 individual participants and 60 different discussion threads. The instructor and teaching assistants were removed from the data. Data from second iteration of the case (Course 2) Study 2 includes 165 individual

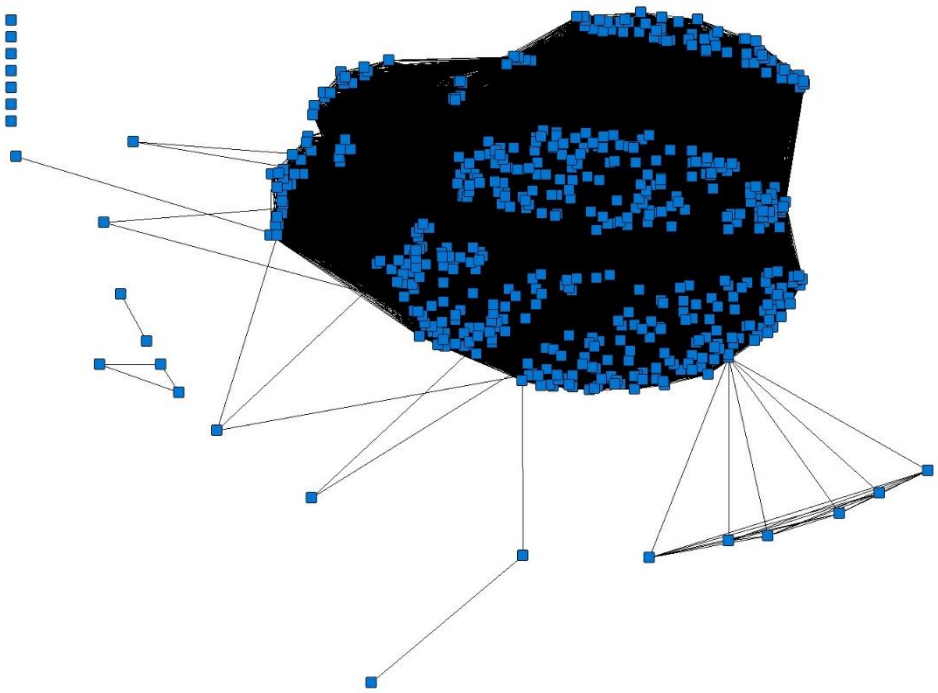
participants and 23 different discussion threads. The instructor and teaching assistants were also removed from the data.

*Figure 13* is a sociogram generated in UCINET showing the connections of all participants in the entire learning network for Course 1. Each node in the sociogram represents a participant, and the edges (lines) that connect the nodes shows that the participants interacted by posting in the same discussion thread. From this sociogram, a few conclusions can be made. First, the large cluster of nodes in the centre suggests that the majority of participants are connected to each other by posting in multiple discussion threads. Second there are smaller clusters of nodes which represent participants who posted in only one discussion thread. For example, the small cluster of three connected nodes indicates that these participants interacted in one discussion thread, only. This also indicates that they have no relational ties with other participants in the xMOOC learning network as they did not interact in any other discussion thread. Participants connected within the small clusters did not participate in other discussion forum threads connected to the largest cluster. Some participants have no relational ties to other participants at all. Participants that show no connection are those who posted a thread discussion only once and received no replies from other participants; additionally, they did not participate in other discussion forum threads. These participants are considered to be isolates, in that they are not part of the main learning network and are not considered for this study. All other participants are included in the social network analysis. *Figure 14* is the sociogram for Course 2, which also illustrates that most participants had a relational tie by

participating in numerous discussion threads, while some are isolates. *Appendix 1* provides an example generated from UCINET.

**Figure 13**

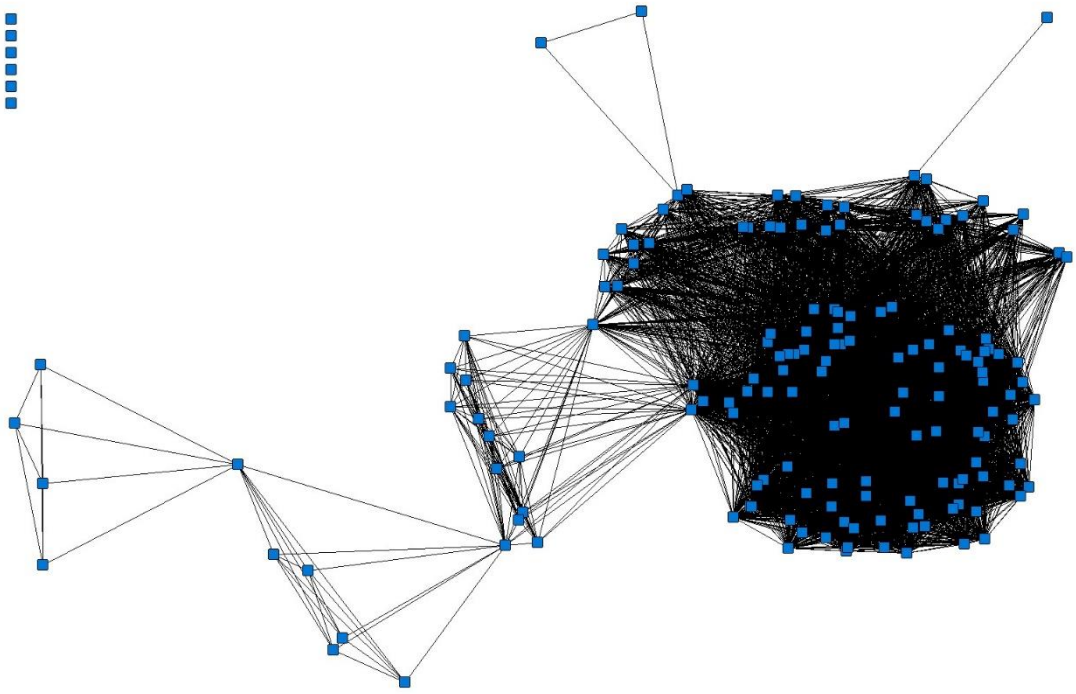
*Sociogram of whole network for Course 1*



*Note. This sociogram indicates that most participants (large cluster in the middle) are connected through their discussion forum participation, while a few are considered isolates (e.g. upper left corner) because they do not participate in the same discussion threads as the majority.*

**Figure 14**

*Sociogram of whole network for Course 2*



*Note. The results of this sociogram are similar to Course 1, indicating that most participants are connected through their discussion forum participation, with some isolates.*

The sociogram is beneficial because it visualizes multiple levels for analysis: the individual participants, clusters of individuals and the whole network. As literature suggests, a sociogram of an entire learning network can assist instructors and facilitators with monitoring and detecting participants' activity in discussion forums (Buraphadeja, 2010; Ergun and Usluel, 2016; Reffay and Chanier, 2002; Shen, Nuankhieo, Huang, Amelung and Laffey, 2008). These sociograms can also provide researchers with insight into how a learning network is structured, allowing them to visualize the network density, identify

both isolated participants and participants that have high degree, betweenness and / or closeness centralities.

Based on the sociogram for Course 1, the network is dense with a relatively small number of isolates and clusters. This is supported by the density score calculated by using UCINET of 0.723. Density is the "number of ties in the network, expressed as a proportion of the number of possible," and "can be interpreted as the probability that a tie exists between any pair of randomly chosen nodes." (Borgatti et al. 2013, p. 150). The closer a number is to 1.0, the denser the network. The sociogram for Course 1 indicates that most participants have relational ties in the network and are participating in numerous discussion threads. Each cluster of nodes represents a discussion thread, and the lines between nodes represents participants' ties to each other as a result of posting in the same thread. The sociogram for Course 2 suggests the network to be less dense, which is supported by the density score of 0.511.

The fact that most participants in each course are connected or affiliated to each other through the discussion forum threads indicates opportunities for knowledge transfer and construction to occur. These sociograms and density scores show that most participants accessed numerous discussion threads in the learning network, allowing them to read (a form of engagement) numerous other participants' content. As Wise and Cui (2018b, p. 332) argue:

> […] reading others' posts represents the reception of ideas (rather than the expression), which is critical to most models of learning through discussion and

> makes up the majority of time users spend in online forums […]. Furthermore, when non-posting behaviours are considered, the proportion of students in a MOOC who can be considered to have participated in (and potentially learned from) the forums grow dramatically.

For instructors and researchers, this is useful because it visualizes what "could be". That is, the dense network suggests there is a high degree of social presence through relational ties, setting the stage for knowledge construction. Social presence,

> as an antecedent of interpersonal interaction, is a critical feature of learning processes which are premised upon the modification of ideas that results from interpersonal communication. In this transactional, interactivist or relational view of learning, meaning is made not only in the context of communicative exchanges, but in the context of the relations between them (Oztok and Kehrwald, 2017, p. 261).

Additionally, as Ergun and Usluel (2016, p. 43) note, "density measurement provides a prediction of the diffusion rate of knowledge between actors". Of course, while useful, this still does not reveal which participants are central to the network or identify who potentially influences or pivots knowledge construction and transfer. Knowing that the network is dense is useful only so far as it indicates potential connections. It is still unclear whether any one participant or a selection of participants poses more influence in the network. To identify these participants, it is important to identify participants who score high in degree, betweenness and closeness centralities.

### 4.2.1 Degree centrality

Degree centrality coefficient measurements are relevant to this study because they identify the number of participants tied to a specific participant. In other words, the result of this measure identifies participants that have numerous ties, are highly connected and the most active in the network.

#### *Course 1*

The results for Course 1 include measurements for 540 participants with the degree of centrality of *Participant 6118f8* scoring the highest at 2290 and the degree centrality of Participants 1-7 scoring the lowest at 0, respectively. The degree centrality mean is 661.778 and the standard deviation is 389.070, and the network centralization is 18.729%, suggesting that there is a low concentration or centralization in this whole network. This means that the positional advantages of participants are rather equally distributed in this network. *Table 7* shows the top 10 participants who scored the highest degree centrality in the network. The degree centrality score is the number of connections to a participant via posts from different discussion threads across the entire learning network. Since *Participant 6118f8* has a degree higher than the total number of participants (540) in the learning network, it can be concluded that they have connected to participants more than once across different discussion threads. *Participant db9ae3*, whose centrality measurement is 2126, has 148 less ties than *Participant 6118f8*1 (2274 – 2126 = 148). This places Participant 2 in a less central position within the learning network. Meanwhile, Participants *d4cd5a*, *3fff24*, and *504a55* have significantly less ties in the social network.

**Table 7**

*Top 10 participants who scored the highest degree centrality for Course 1*

| Participant | Degree |
|---|---|
| *6118f8*1 | 2274 |
| *db9ae3* | 2126 |
| *f5d21a* | 1839 |
| *e4e78d* | 1828 |
| *b38f98* | 1798 |
| *583ed7* | 1786 |
| *bba03d* | 1642 |
| *d4cd5a* | 1572 |
| *3fff24* | 1572 |
| *504a55* | 1572 |

*Table 8* shows the bottom 10 participants who scored the lowest in degree. These participants are considered to be isolates as their degree measures indicate that they lack relational ties in the learning network. For example, *Participant 61763e's* degree of 0 indicates that they started a thread in the discussion forum; however, no one responded to them. Additionally, they have not posted in any other discussion thread. *Participant 684dc9* has posted in only one discussion thread as well; however, the difference here is that one other participant posted in the same thread. None of these participants are considered to be in a position that is influential in the learning network.

**Table 8**

*Bottom 10 participants who scored the lowest degree centrality for Course 1*

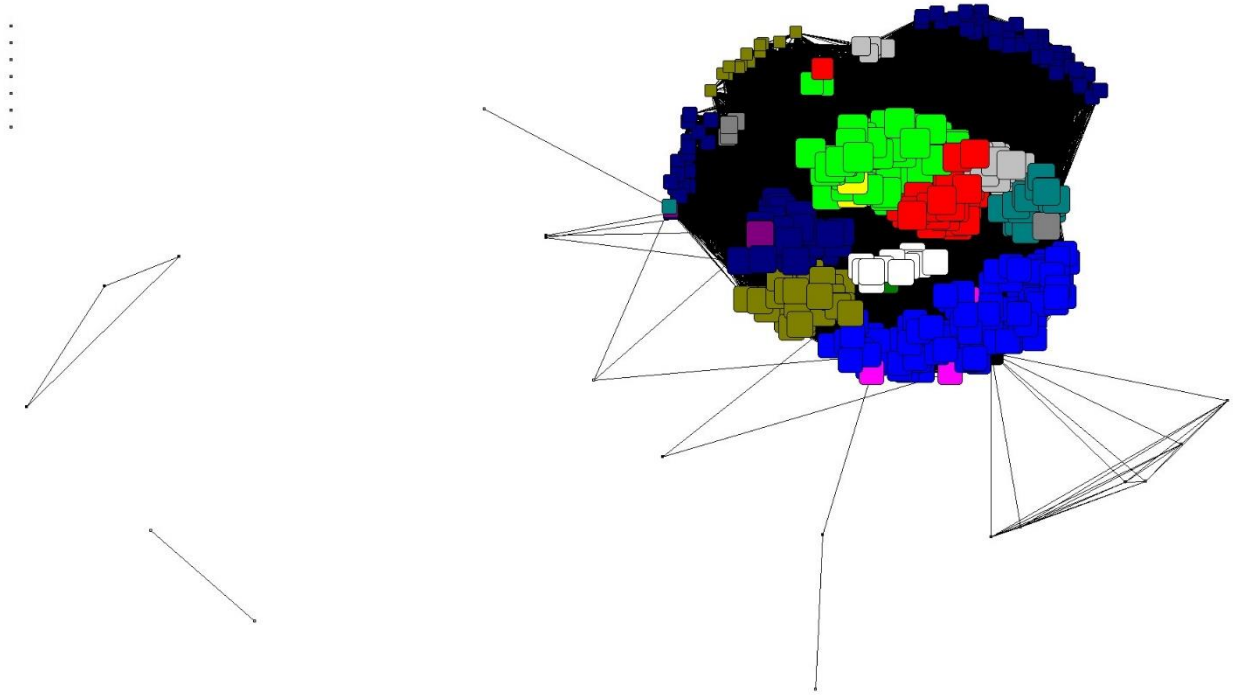
| Participant | Degree |
|---|---|
| 684dc9 | 1 |
| 6868ff | 1 |
| 42cf88 | 1 |
| 3eafd4 | 0 |
| a1267d | 0 |
| b358fc | 0 |
| e9ec52 | 0 |
| 1932e9 | 0 |
| 23d8ae | 0 |
| 61763e | 0 |

*Figure 15* visualizes the entire network. Here, the node size is based on degree centrality, and colour indicates nodes that share equal degree centrality scores. The seven isolated nodes on the upper left corner represent the participants with a degree of 0 in Table 8. The largest node found in the larger cluster represents *Participant 6118f8*1. This visualization helps with understanding the position of a participant in the network. For a teacher, for example, it becomes clear which students might be isolated from the learning network and

which are placed in an influential position or is contributing frequently in the discussion forum and, as a result, creating numerous relational ties with others.

**Figure 15**

*Sociogram of degree centrality for Course 1*



*Note. The size of each node indicates their degree centrality measure; the larger the node, the higher their degree centrality.*

### *Course 2*

The results for Course 2 include measurements for 165 participants with the degree of centrality of *Participant 0786ec* scoring the highest at 683 and the degree centrality of Participants *f33563*, *1cae2a*, *f01d57*, *f4e190*, *778513* and *248933* scoring the lowest at 0, respectively. The degree centrality mean is 168.655, the standard deviation is 132.70, and

the network centralization is 19.84%, suggesting that there is a low concentration or centralization in this whole network. This means that the positional advantages of participants are rather equally distributed in this network. *Table 9* shows the top 10 participants who scored the highest degree centrality in the network. Since *Participant 0786ec* has a degree higher than the total number of participants (165) in the learning network, it can be concluded that they have connected to participants more than once across different discussion threads. *Participant 860e5d*, whose centrality measurement is 574, has 109 less ties than *Participant 0786ec*. This places *Participant 860e5d* in a less central position within the learning network. Meanwhile, Participants *be1af3*, *9c908d*, and *e3f162* have significantly less ties in the social network.

**Table 9**

*Top 10 participants who scored the highest degree centrality for Course 2*

| Participant | Degree |
|---|---|
| *0786ec* | 683 |
| *860e5d* | 574 |
| *4742a0* | 527 |
| *d5a7fd* | 466 |
| *622aeb* | 444 |
| *cc7442* | 412 |
| *cbfcd2* | 412 |
| *be1af3* | 409 |

| | |
|---|---|
| *9c908d* | 353 |
| *e3f162* | 353 |

*Table 10* shows the bottom 10 participants who scored the lowest. These participants are considered to be isolates as their degree measures indicate that they lack relational ties in the learning network. For example, *Participant 248933's* degree of 0 indicates that they started a thread in the discussion forum; however, no one responded to them. Additionally, they have not posted in any other discussion thread. *Participant 6c0b4f* has posted in only a few discussion threads and has made 5 relational ties with other participants as a result. This indicates that few participants in the learning network have posted in the same threads as *Participant 6c0b4f*. None of these participants are considered to be in a position that is influential in the learning network.

**Table 10**

*Bottom 10 participants who scored the lowest degree centrality for Course 2*

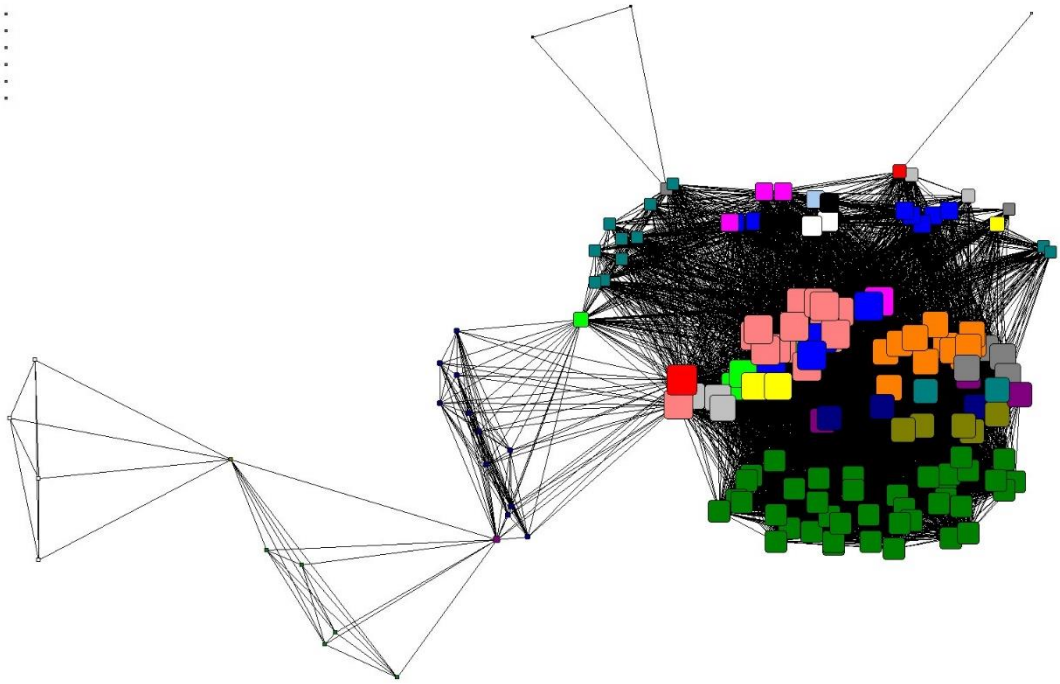
| Participant | Degree |
|---|---|
| *6c0b4f* | 5 |
| *df22b3* | 3 |
| *acc498* | 3 |
| *d0f02d* | 1 |
| *f33563* | 0 |

| | |
|---|---|
| *1cae2a* | 0 |
| *f01d57* | 0 |
| *f4e190* | 0 |
| *778513* | 0 |
| *248933* | 0 |

*Figure 16* visualizes the entire network where the node size is based on degree-centrality, and colour indicates nodes that share equal degree centrality scores. The six isolated nodes on the upper left corner represent the participants with a degree of 0 in Table 10. The largest node found in the larger cluster represents *Participant 0786ec*. This visualization helps with understanding the position of a participant in the network. As mentioned, this enables teachers to identify students who are isolated from the learning network and students who are placed in an influential position or are contributing frequently in the discussion forum.

**Figure 16**

*Sociogram of degree centrality for Course 2*



*Note. The size of each node indicates their degree centrality measure; the larger the node, the higher their degree centrality.*

### *Discussion about Course 1 and 2 degree centrality*

Identifying participants with high degree centrality provides insight on who potentially has influence on knowledge construction and transfer within each network. Findings that there is a low concentration or centralization in both networks indicates that only a small number of participants are in a position to be connectors in the networks. The findings also indicate that the majority of participants share equal influence on the networks' knowledge flow. These findings are useful in that they help narrow down the number of potential

connectors who may be pivotal in knowledge construction within the network. This helps eliminate the majority of participants as connectors and identifies a few who are the most connected within a network. These are the participants who meet Gladwell's (2000) criteria to be connectors because they have established the most relational ties in the network and have access to the majority of content discussed in the discussion forums. This places them in a position of "information stewards" where they are able to not only collect information from other participants but also help distribute knowledge across the learning network (Gladwell, 2000). As a complex system, distributed knowledge is shared and circulated throughout a learning network and its participants: "processing information and feedback for learning is not routed through a central control mechanism; it is distributed throughout the system, and information, knowledge and meanings and their control are also distributed throughout the system" (Morrison, 2002, p. 19). Connectors, who have the highest degree centrality, are in a position to influence the distribution of knowledge.

By identifying these participants, we can posit that everyone in the network has had the opportunity of reading and or interacting with these connectors. If an emergent property from the whole learning network is knowledge construction, then it makes logical sense that the multiple actors need to be identified, particularly the connectors who are central within the network. And, as literature suggests (e.g. Nakano et al., 2015; Gašević et al., 2019). actors that have high degree centrality have the potential to influence interactions and engagements throughout the network. Of course, it is important to stress that connection is not equal to interaction or engagement. Nevertheless, by identifying

connecters with high degree of centrality, it is possible to now analyse their contributions to the network and determine whether they provide leadership or initiate pivotal moments in the discussion threads, which is necessary for facilitating discourse that enables knowledge construction (Garrison, 2016).

### 4.2.2 Betweenness centrality

Between centrality coefficient measurements are relevant to this study because they identify the participants that may be key "mediators" or brokers of information and knowledge construction in linking other participants. In this sense, participants with high betweenness may have some degree of control over how discussion occurs in the forum threads. Furthermore, they may be pivotal in connecting participants' knowledge or discourse who may otherwise not ever connect to. In other words, they are the weak ties that bridge knowledge across groups of participants.

#### *Course 1*

The results include measurements for 540 participants with the degree of betweenness of *Participant e80046* scoring the highest at 3126, with *Participant fc9105* scoring 1050 and *Participant 440744* scoring 625. The lowest betweenness centrality score is 0, and includes 245 participants. The betweenness centrality mean is 66.381, the standard deviation is 159.276 and the network centralization is 2.11%, indicating there is little "betweenness" in the whole network. This means that the majority of the connections can be made in this network without the aid of one participant. *Table 11* shows the top 10 participants who

scored the highest betweenness centrality in the network. Participants with high betweenness centrality are in a position to connect other participants within the learning network. This means that *Participant e80046* is in a better position, for example, than *Participant fc9105* to connect a participant to another. Or, in relation to distributed knowledge, *Participant e80046* is in the best position to act as a "gatekeeper" of knowledge. As Dawson's (2008) findings suggest, these "gatekeepers" or "brokers" influence the flow of information and resources in a learning network.

**Table 11**
*Top 10 participants who scored the highest betweenness centrality for Course 1*

| Participant | Betweenness |
|---|---|
| *e80046* | 3126 |
| *fc9105* | 1050 |
| *4407ff* | 625 |
| *ba1f3b* | 535 |
| *75363f* | 526 |
| *a8a619* | 464 |
| *c38ce3* | 446 |
| *4c26d3* | 328 |
| *f5d21a* | 296 |
| *d25f50* | 244 |

*Table 12* shows the bottom 10 participants who scored the lowest for betweenness centrality. These participants have no influence on how knowledge is distributed across the network as their position does not place them in-between other participants. None of these participants are considered to be in a position that is influential in the learning network because they are not in a "bridging" role. In other words, they do not have strong or weak relational ties within the learning network.

**Table 12**
*Bottom 10 participants who scored the lowest betweenness centrality for Course 1*

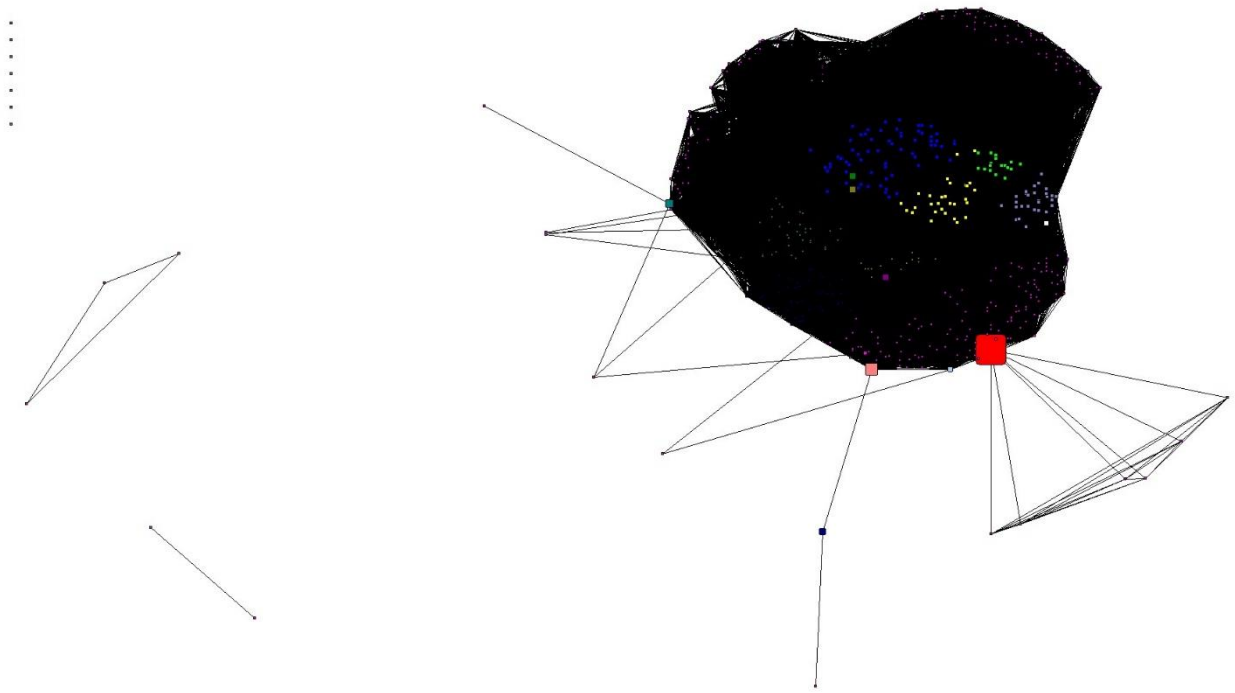
| Participant | Betweenness |
|---|---|
| *b37c1c* | 0 |
| *e7a810* | 0 |
| *45c5f4* | 0 |
| *2510a5* | 0 |
| *e155ab* | 0 |
| *a59419* | 0 |
| *b461dc* | 0 |
| *20ffcd* | 0 |
| *f6017d* | 0 |
| *e9808a* | 0 |

*Note. These participants have no betweenness centrality, which means they are not in any position to "broker" knowledge.*

*Figure 17* visualizes the entire network where the node size is based on betweenness centrality; the larger the node the higher their betweenness centrality. Colour indicates nodes that share equal degree centrality scores. Findings from this visualization confirms that one participant stands out as a connector with high betweenness: *Participant e80046.*

**Figure 17**

*Sociogram of betweenness centrality for Course 1*



*Note. The size of each node indicates their betweenness centrality measures for Course 1. This sociogram indicates that the majority of participants have little to no betweenness centrality, while a few participants clearly have high betweenness centrality.*

### *Course 2*

The results include measurements for 165 participants with the degree of betweenness of *Participant dbca72* scoring the highest at 1480, with *Participant 60bd69* scoring 1435 and *Participant 090d6e* scoring 1220. The lowest betweenness centrality score is 0, and includes 85 participants. The betweenness centrality mean is 48.382, the standard deviation is 192.471 and the network centralization is 10.78%, indicating there is little

"betweenness" in the whole network. This means that the majority of the connections can be made in this network without the aid of one participant. However, the network centralization is higher for Course 2 compared to Course 1. *Table 13* shows the top 10 participants who scored the highest betweenness centrality in the network.

**Table 13**
*Top 10 participants who scored the highest betweenness centrality for Course 2*

| Participant | Betweenness |
|---|---|
| *dbca72* | 1480 |
| *60bd69* | 1435 |
| *090d6e* | 1220 |
| *7ca495* | 616 |
| *afb618* | 384 |
| *c9e0db* | 312 |
| *814048* | 157 |
| *8bb3e1* | 63 |
| *9c908d* | 63 |
| *e3f162* | 63 |

*Table 14* shows the bottom 10 participants who scored the lowest. As with Course 1, these participants have no influence on how knowledge is distributed across the network as their position does not place them in-between other participants. As a result, they are also not considered to be in a position that is influential in the learning network.

**Table 14**
*Bottom 10 participants who scored the lowest betweenness centrality for Course 2*

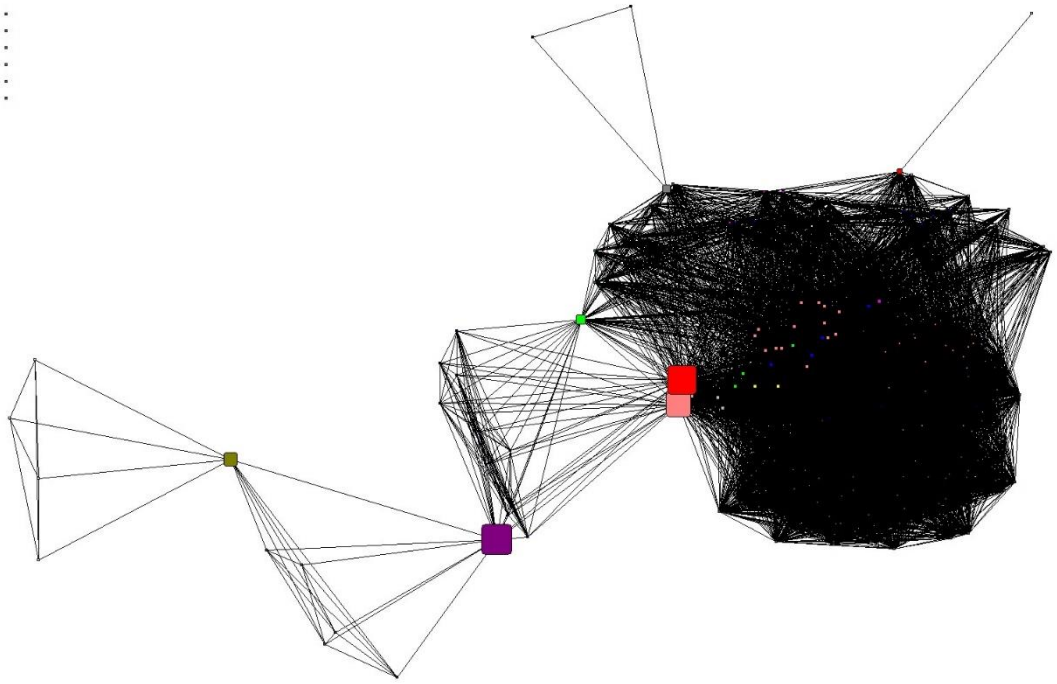
| Participant | Betweenness |
|---|---|
| *c34bba* | 0 |
| *f01d57* | 0 |
| *815206* | 0 |

| | |
|---|---|
| *f9bacf* | 0 |
| *e37b60* | 0 |
| *1d67da* | 0 |
| *3af159* | 0 |
| *a0ad3d* | 0 |
| *2f374d* | 0 |
| *e3f162* | 0 |

*Note. This is similar to Course 1 where many participants have no betweenness centrality, which means they are not in any position to "broker" knowledge.*

*Figure 18* visualizes the entire network where the node size is based on betweenness centrality, and colour indicates nodes that share equal degree centrality scores. Findings from this visualization show that three participants in particular are in a position to act as "gatekeepers" between clusters of participants. For example, the large purple node is in a position to act as a gatekeeper between the small cluster of participants on the bottom left of the sociogram and the middle cluster. The red node is a "gatekeeper" between the small middle cluster and the larger cluster of participants.

**Figure 18**
*Sociogram of betweenness centrality for Course 2*



*Note. The size of each node indicates their betweenness centrality measures for Course 1. The results of this sociogram are similar to Course 1 where the majority of participants have little to no betweenness centrality, while a few participants clearly have high betweenness centrality.*

### *Discussion about Course 1 and 2 Betweenness Centrality*

These findings indicate that opportunities for weak ties exist in the MOOC learning networks. This is important to consider because participants with high betweenness centrality are in a position that supports learning ties; that is, these relational ties are the kind that provide exchanges among participants of specific kinds of knowledge

transmission that impacts knowledge construction (Dawson, 2008). Studies in educational contexts, like Jiang et al.'s (2014), and business contexts, like Hansen, (1999); and Levin and Cross, (2004) show that participants with high betweenness centrality measures have some degree of control over the communication of others. From a complex systems perspective, this position allows a participant to emerge as a "broker" of knowledge, choosing what to share and influence what others in the network discuss.

This is also important to consider in relation to what Haythornthwaite and de Laat (2012) say about learning relations as inputs for design. Identifying these relations "provides insight that can be used for design of learning spaces, educational interventions and information systems" to encourage the kind of exchanges that create understanding, social support and knowledge constructions during the learning process. Considering this, it's worth exploring what and how participants with high betweenness centrality communicate in the discussion forums. Whether these kinds of participants emerge spontaneously as connectors and are pivotal or not in knowledge construction may not be important. What is important is that these kinds of connectors exist, and, in turn, specific instructional design tasks could be created to capitalize on their weak ties.

### 4.2.3 Closeness centrality

Closeness centrality coefficient measurements can indicate the degree to which a participant is closer to other participants, "based on the geodesic distance". What this means is that if someone wants to distribute information through the network, a

participant with high closeness centrality would be able to deliver the message to other participants quickly. High closeness centrality suggests a learner is in "the middle of what is happening on the forum" (Dowell et al., 2015).

### *Course 1*

Course 1 includes measurements for 540 participants. Findings show that *Participants a8a619* and *c38ce3* score the highest for closeness centrality at 7.678, and *Participants 684dc9, 807d9c, 5c324e, e8ba9c, c92416* score the lowest at 0.186. There are six participants with no closeness centrality score because they only contributed by starting a discussion thread in which no one contributed to and they did not contribute to any other discussion thread. The closeness centrality mean is 7.48 and the standard deviation is 0.722. Findings indicate that there is no significant difference among most participants in how close they are to others in the network. As a result, it matters little who is contacted to disseminate information though the network as most participants have similar closeness measurements. The reason for this is that most participants are participating in the same threads at least once. *Table 15* shows the top 10 participants who scored the highest closeness centrality in the network. The table makes it clear that the differences in closeness centrality are not significant for one participant to be more influential in the network over another.

**Table 15**
*Top 10 participants who scored the highest closeness centrality for Course 1*

| Participant | Closeness |
|---|---|
| *a8a619* | 7.678 |
| *c38ce3* | 7.678 |
| *003c5a* | 7.677 |
| *f48945* | 7.677 |
| *e9b76d* | 7.677 |
| *2947b1* | 7.677 |
| *01db66* | 7.677 |
| *7ae9fb* | 7.677 |
| *b1e5a3* | 7.677 |
| *74bcc9* | 7.677 |

*Table 16* shows the bottom 10 participants who scored the lowest. What the table doesn't show is that the 13th participant from the bottom has a closeness centrality of 6.587. What this signifies is there are only a small few who are not easily reachable in the whole learning network. The seven participants with a closeness centrality of 0 are not reachable because they do not post in discussion threads other than the ones they created; additionally, no one posts in the discussion threads they created.

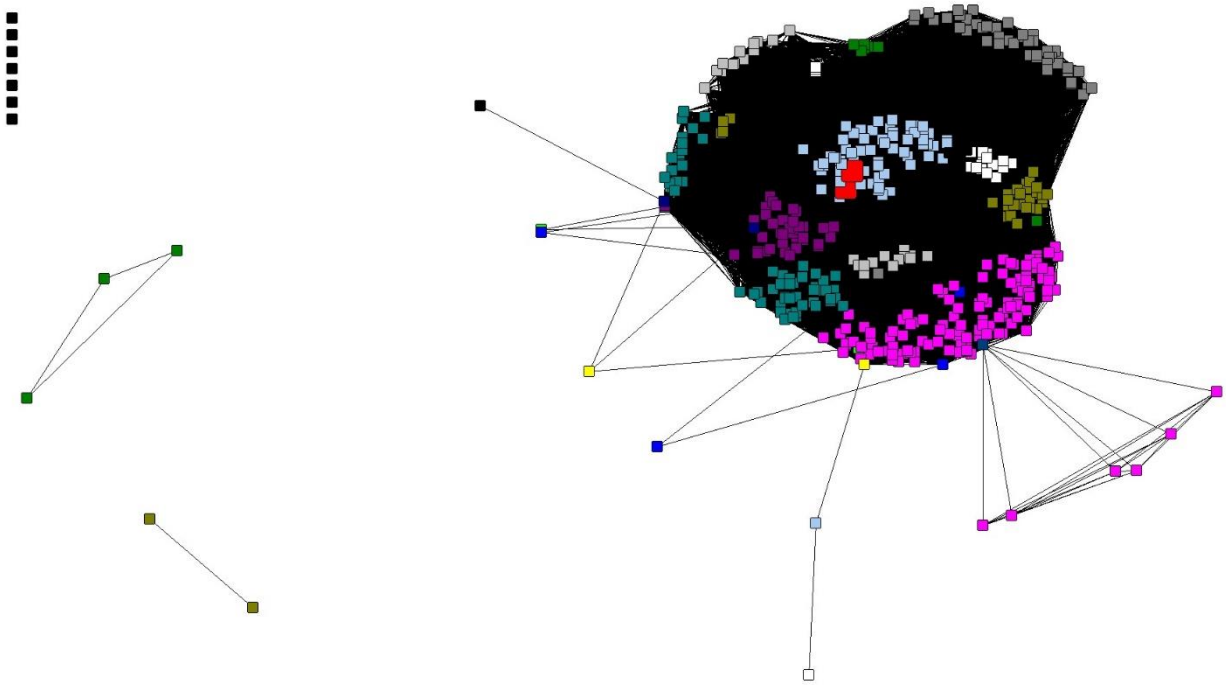
**Table 16**
*Bottom 10 participants who scored the lowest closeness centrality for Course 1*

| Participant | Closeness |
|---|---|
| *e8ba9c* | 0.186 |
| c944f2 | 0.186 |
| *684dc9* | 0.186 |
| *3eafd4* | 0 |
| *a1267d* | 0 |
| *b358fc* | 0 |
| *e9ec52* | 0 |
| *1932e9* | 0 |
| *23d8ae* | 0 |
| *61763e* | 0 |

*Figure 19* visualizes the entire network where the node size is based on closeness centrality. These findings suggest that most learners are close to each other in that they are posting in the same discussion threads, and that most participants are, therefore, in "the middle of what is happening on the forum".

**Figure 19**

*Sociogram of closeness centrality for Course 1*



*Note. The size of each node indicates their closeness centrality measures for Course 1. The results of this sociogram indicates that the majority of participants have similar closeness centrality, while two participants clearly have higher closeness centrality.*

### *Course 2*

The results from Course 2 include measurements for 165 participants with the degree of closeness of *Participant* scoring the highest at 14.029, and *Participant 090d6e* scoring the second highest at 12.922. *Participants 06329b, 9686fe, 73739a, 6c0b4f* scored the lowest at 10.308. There are six participants with no closeness centrality score because they only contributed by starting a discussion thread in which no one contributed to and they did not contribute to any other discussion thread. The closeness centrality mean is 13.183 and the standard deviation is 0.733. *Table 17* shows the top 10 participants who scored the highest closeness centrality in the network. Similar to Course 1, the table makes it clear that the differences in closeness centrality are not significant for one participant to be more influential in the network over another.

**Table 17**
*Top 10 participants who scored the highest closeness centrality for Course 2*

| Participant | Closeness |
|---|---|
| *60bd69* | 14.029 |
| *090d6e* | 13.922 |
| *cc7442* | 13.816 |
| *e3f162* | 13.816 |
| *11d196* | 13.816 |
| *4742a0* | 13.816 |
| *9c908d* | 13.816 |
| *f346c8* | 13.816 |
| *d5a7fd* | 13.816 |
| *ea8ff4* | 13.816 |

*Table 18* shows the bottom 10 participants who scored the lowest. Like Course 1, there are participants who create their own discussion thread but never post in other discussion threads. There is a slight difference between the two networks in that Course 1 has a

couple of smaller clusters of participants. Whereas, the table indicates that participants at the bottom of the closeness centrality, apart from those who score 0, are just as likely to be reachable as others in the network.

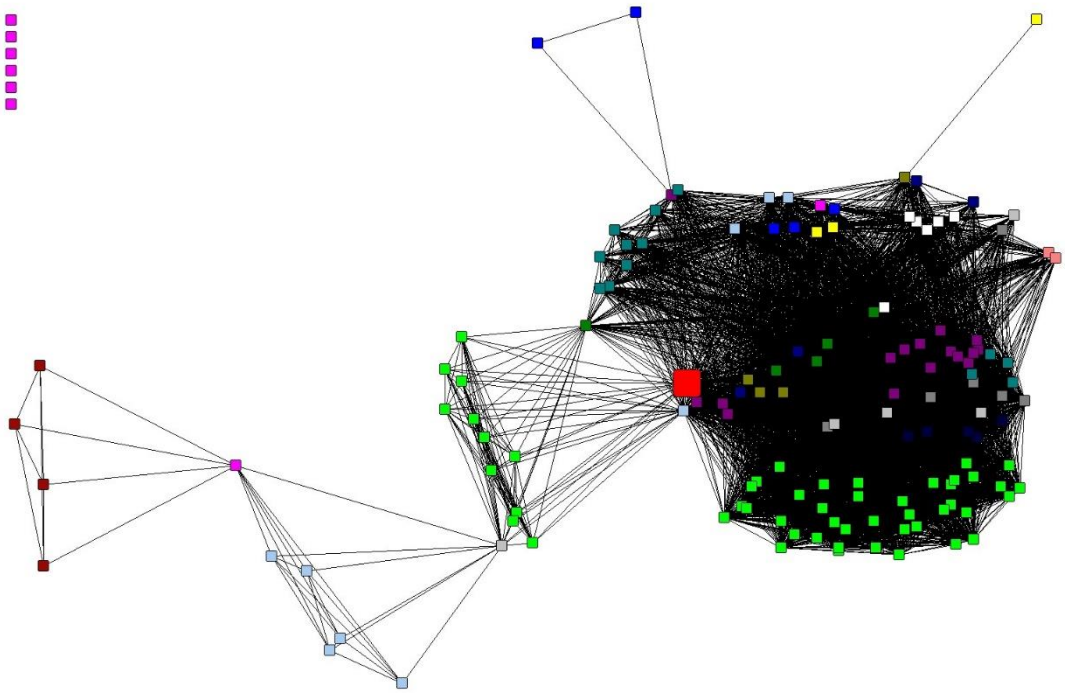
**Table 18**
*Bottom 10 participants who scored the lowest closeness centrality for Course 2*

| Participant | Closeness |
|---|---|
| *6c0b4f* | 10.308 |
| *73739a* | 10.308 |
| *9686fe* | 10.308 |
| *06329b* | 10.308 |
| *f33563* | 0 |
| *1cae2a* | 0 |
| *f01d57* | 0 |
| *f4e190* | 0 |
| *778513* | 0 |
| *248933* | 0 |

*Figure 20* visualizes the entire network where the node size is based on closeness centrality. These findings are similar to Course 1, in that it suggests that most learners are close to each other in that they are posting in the same discussion threads, and that most participants are, therefore, in "the middle of what is happening on the forum".

**Figure 20**

*Sociogram of closeness centrality for Course 2*



*Note. The size of each node indicates their closeness centrality measures for Course 1. The results of this sociogram are similar to Course 1, indicating that the majority of participants have similar closeness centrality, while only one participant clearly has higher closeness centrality.*

### *Discussion about Course 1 and 2*

Results from both courses indicate that most participants are contributing to the same discussion threads and, by default, are close through association in the forum. Considering this then, it appears that there are no specific participants who have significant closeness

centrality to consider. Mostly everyone has similar opportunities to establish ties with one another through their close ties because they are contributing to and reading the same discussion threads. This is most likely because formal tasks are assigned in the course for students to participate in the discussion forum activities.

### 4.2.4 Interpretation and discussion of centrality scores

In both courses, there are distinct MOOC participants who have higher degree centrality or betweenness scores than others in the learning network, which is similar to the findings in Jiang's et al. (2014) study in that MOOC discussion forums are "dominated by a small percentage of learners who contributed more than the rest of learners". What is interesting here is the question of whether these distinct participants contribute to or are pivotal in the process of knowledge construction. Jiang at el. (2014) argue that MOOC discussion forums are dominated by a group of learners or a knowledge source who "helps to build up and maintain the network." However, it's unclear whether these connectors with high degree or betweenness centrality do in fact influence the knowledge construction process.

By referring to Freeman's (1979) definition, participants with high degree centrality should be "in the thick of things" and have the "potential for activity in communication" within the entire network and should be seen as a "major channel of information" or a "focal point of communication" with those whom they have contact with. Additionally, participants who have high betweenness centrality are potentially influential in the learning network because "a person in such a position can influence the group by withholding or distorting

information in transmission", and they "are in a position for the "maintenance of communication" and the "potential as coordinators of group processes" (Freeman, 1979). Freeman also notes that high closeness centrality scores indicate that a "point [participant] is viewed as central to the extent that it can avoid the control potential of others" and a message from that point would spread throughout the network quickly and efficiently. However, there is no significant or distinct participants with high closeness centralities in both courses for this study. The reasons being as findings indicate that most participants are contributing to the same discussion threads and, by default, are close through association in the forum. Therefore, high closeness centrality is not considered a category of connectors.

In short, participants with high degree centrality or high betweenness scores are distinct categories of connectors and were identified for IAM content analysis. This aligns with Gunawardena et al. (2016) in that these categories of participants are either central to the entire network through the frequency of their posting (degree centrality) or they have the potential for being information "brokers" (betweenness centrality) or "mavens". As Kovanovic et al. (2014, p. 6) note "it would be very interesting to investigate whether there are any particular ways in which the students with the high betweenness centrality differ from the other students (e.g., asking many questions or exhibiting higher self-disclosure)". This would also align with Gašević et al. (2019) who suggest that MOOC participants who have high scores in these centralities also show activity in collaborative learning.

As noted, three centrality scores, degree centrality, betweenness centrality, and closeness centrality, were considered for identifying categories of connectors. The purpose was to help identify possible influential participants in the learning networks of the two courses. Only degree and betweenness centrality scores are considered to be significant to categorize as connectors. It should be noted that, as individual connector categories (degree, betweenness), these participants are in a position to play different roles, and, as a result, may or may not influence pivotal moments of knowledge construction in the discussion forums.

Of course, some participants may fall into more than one connector category. For example, a participant who scores high in degree centrality may also score high in betweenness centrality, or some other combination. Considering this, it is also important to identify connectors that have a combination of high centrality score because they will most likely be highly involved in discussion forum activity, and, as a consequence, take on different roles to support knowledge construction within a network. For example, if a connector has high degree centrality and high betweenness centrality, they are in a position in the network to have access the large amounts of information that passes through the network, and they are also in a position to control how that information is distributed among other participants in the network or specific discussion threads. More specifically, this category of connector will have read content from numerous posts in the learning network, while contributing to most discussion threads. Because there are less relational ties among other participants, this category of connectors is positioned to control information flow,

determining how information from threads others have not read is brought into a discussion.

As mentioned, there are no specific participants who have significant closeness centrality and it is assumed that everyone has near similar opportunities to establish ties with one another through their close ties because they are contributing to and reading the same discussion threads. However, when comparing centrality scores, findings in Course 1 indicate that two participants with the highest closeness centrality score also have high betweenness scores, and findings in Course 2 indicate that four participants with high closeness centrality scores have high betweenness scores. As a result, these participants are considered to be connectors who possibly have influence within the learning network and are labelled as connectors with high betweenness and closeness centrality.

For Course 1, data results indicate some participants scored high in more than one centrality measurement. *Table 19* shows the top scoring participants side-by-side for selected measures. The highlighted participants are those who scored high in more than one centrality. *Participants 6118f8* and *db9ae3* score high degree and closeness centralities; *Participant f5d21a* scores high degree and between centralities; *Participants a8a619* and

**Table 19**

*Top scoring participants side-by-side for selected measures from Course 1*

| **High Degree** | | | | **High Betweenness** | | | | **High Closeness** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Participant** | **Degree** | **Betweenness** | **Closeness** | **Participant** | **Betweenness** | **Degree** | **Closeness** | **Participant** | **Closeness** | **Degree** | **Betweenness** |
| ***6118f8**** | **2290** | **161.408** | **7.677** | *e80036* | 3126 | 875 | 7.561 | ***a8a619**** | **7.678** | **1148** | **464.508** |
| ***db9ae3**** | **2148** | **161.408** | **7.677** | *Fc9105* | 1050 | 436 | 7.556 | ***c38ce3**** | **7.678** | **1149** | **446.008** |
| ***f5d21a**** | **1854** | **296.666** | **7.618** | *4407f* | 625.59 | 266 | 7.38 | *003c5a* | 7.677 | 1145 | 161.408 |
| *e4e78d* | 1838 | 161.408 | 7.677 | *ba1f3b* | 535.286 | 1288 | 7.59 | *f48945* | 7.677 | 1145 | 161.408 |
| *b38f98* | 1809 | 131.515 | 7.662 | *75363* | 526 | 5 | 7.554 | *e9b76d* | 7.677 | 1145 | 161.408 |
| *583f98* | 1801 | 161.408 | 7.677 | ***a8a619**** | **464.508** | **1148** | **7.678** | *2947b1* | 7.677 | 1145 | 161.408 |
| *bba03d* | 1652 | 161.408 | 7.677 | ***c38ce3**** | **446.008** | **1149** | **7.678** | *01db66* | 7.677 | 1145 | 161.408 |
| *d4cd5a* | 1579 | 161.408 | 7.677 | *4c26d3* | 328.743 | 1288 | 7.59 | *7ae9fb* | 7.677 | 1145 | 161.408 |
| *3fff24* | 1579 | 161.408 | 7.677 | ***f5d21a**** | **296.666** | **1854** | **7.618** | *b1e5a3* | 7.677 | 1145 | 161.408 |
| *504a55* | 1579 | 161.408 | 7.677 | *d25f50* | 244.71 | 442 | 7.555 | *74bcc9* | 7.677 | 1145 | 161.408 |

*Note. This table shows participants who scored high in more than one centrality for Course 1.*

*c38ce3* score high in betweenness and closeness centralities. These participants were identified as connectors for IAM content analysis (*Table 20*).

**Table 20**

*Identified connectors from Course 1*

| Participant | Connector Category |
|---|---|
| 6118f8 | High degree and closeness |
| db9ae3 | High degree and closeness |
| f5d21a | High degree and betweenness |
| a8a619c | High betweenness and closeness |
| c38ce3 | High betweenness and closeness |

For Course 2, data results indicate some participants scored high in more than one centrality measurement. Table 21 shows the top scoring participants side-by-side for selected measures. The highlighted participants are those who scored high in more than one centrality. *Participants 4742a0* and *d5a7fd* score high degree, betweenness and closeness centralities; *Participants 60bd69* and *090d6e* score high betweenness and closeness centralities. These participants were identified as connectors for IAM content analysis (*Table 22*).

**Table 21**

Top scoring participants side-by-side for selected measures from Course 2

| **High Degree** | | | | **High Betweenness** | | | | **High Closeness** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Participant** | **Degree** | **Betweenness** | **Closeness** | **Participant** | **Betweenness** | **Degree** | **Closeness** | **Participant** | **Closeness** | **Degree** | **Betweenness** |
| *0786ec* | 683 | 57.598 | 13.793 | *dbca72* | 1480 | 21 | 12.684 | ***60bd69**** | **14.029** | **250** | **1435.416** |
| *860e5d* | 574 | 52.738 | 13.758 | ***60bd69**** | **1435.416** | **250** | **14.029** | ***090d6e**** | **13.922** | **189** | **1220.153** |
| ***4742a0**** | **527** | **63.469** | **13.816** | ***090d6e**** | **1220.143** | **189** | **13.922** | *8bb3e1* | 13.816 | 353 | 63.469 |
| ***d5a75d**** | **466** | **63.469** | **13.816** | *7ca495* | 616 | 12 | 11.41 | *cbfcd2* | 13.816 | 412 | 63.469 |
| *622aeb* | 444 | 0 | 13.399 | *afb618* | 384.57 | 134 | 13.131 | *e3f162* | 13.816 | 353 | 63.469 |
| *cc7442* | 412 | 63.469 | 13.816 | *c9e0db* | 312 | 65 | 12.924 | *11d196* | 13.816 | 353 | 63.469 |
| *cbfcd2* | 412 | 63.469 | 13.816 | *814048* | 157 | 62 | 12.954 | ***4742a0**** | **13.816** | **527** | **63.469** |
| *be1af3* | 409 | 57.598 | 13.793 | *8bb3e1* | 63.469 | 353 | 13.816 | *9c908d* | 13.816 | 353 | 63.469 |
| *9c9048* | 353 | 63.469 | 13.816 | *9c908d* | 63.469 | 353 | 13.816 | *f346c8* | 13.816 | 353 | 63.469 |
| *e3f162* | 353 | 63.469 | 13.816 | *e3f162* | 63.469 | 353 | 13.816 | ***d5a7fd**** | **13.816** | **353** | **63.469** |

*Note. This table shows participants who scored high in more than one centrality for Course 2.*

**Table 22**

*Identified connectors for Course 2*

| Participant | Connector Category |
|---|---|
| 4742a0 | High degree, betweenness and closeness |
| d5a7fd | High degree, betweenness and closeness |
| 60bd69 | High betweenness and closeness |
| 090d6e | High betweenness and closeness |

These findings are relevant because the relational ties show who is central on different levels within the network, revealing multiple possible patterns where knowledge can be brokered by more than one participant. They also show all participants' involvement in the network and their relational ties, whom connects to whom. From these findings, it is clear that there is a possibility for knowledge to be distributed across the network through interactions with highly connected participants who bridge connections with other participants otherwise not as well connected. This, of course, shouldn't be unexpected given the affordances of discussion forums. These connectors are in a position to establish opportunities for more knowledgeable participants to, for example, facilitate collaborative dialogue, share relevant information needed for learning, or negotiate meaning (Haythornthwaite, 2019; Hodgson et al. 2012; Kop, 2012). However, this cannot be observed through SNA alone. The SNA findings only indicate that a few participants with high centrality are in a position to capitalize on those opportunities. Further analysis is needed to measure whether they do this, which is the purpose of Phase 2 of this study.

In the case of these findings, participants with high degree centrality or high betweenness scores have the possibility of taking on roles that: lead discussion, shape argument, synthesize discussion points, and influence the direction of discussion (Haythornthwaite, 2019; Wise and Chiu, 2011). Additionally, these participants are in a position that allows meaning to be negotiated and created through dialogue (Hodgson et al., 2012). This becomes more meaningful for analysing knowledge construction in comparison to identifying participants who are active versus passive, observing, or lurking (Hill, 2013; Ramesh et al., 2014; Coffrin et al. 2014). Without identifying the relational ties, it is difficult to measure whether collaborative dialogue occurs, or if it does, with whom. It is also unclear whether claims that MOOC participants need guidance from facilitators with creating knowledge, as suggested to be the case for cMOOCs (Kop, 2012). If xMOOCs are complex systems where self-organization and emergence occurs as the result of the interaction of participants within the learning network, then connectors are at the centre of it all with the power to influence how other participants behave.

The next logical step, then, would be to analyse social interaction in the discussion forums to determine whether participants' social ties, and the identified connectors, do foster knowledge construction or whether connectors influence, or "broker" knowledge construction. Jiang et al, (2014, p. 26) suggest that participants who

> exhibit a high level of interactive social presence have higher chances of 'provoking' a response from the other students. Activities such as asking questions, explicitly referring to other students by name, quoting their messages, complementing them

or agreeing with their messages, are all activities associated with an interactive and open communication.

As De Laat et al. (2007) suggest, combining content analysis with social network analysis will provide a more comprehensive view of what these connectors contribute in the discussion forums.

## 4.3 Phase 2: IAM Content Analysis findings and discussion

This section reports on the IAM content analysis of discussion forum contributions by the connectors identified from the social network analysis findings from Course 1 and Course 2, including the identification of phases of KC and KC patterns. The IAM content analysis was used to address the second research question: How do these connectors support knowledge construction in the discussion forums? Findings suggest that there is no clear evidence that any category of connector have a significant role in knowledge construction.

### 4.3.1 General Results and Discussion

As mentioned earlier, a well-known model used for measuring levels of knowledge construction is the interaction analysis model (IAM) (Gunawardena et al., 1997). The IAM considers knowledge construction to be a social phenomenon and conceptualizes the KC process in five phases: (1) Sharing Information, (2) Exploring Dissonance, (3) Negotiating Meaning, (4) Testing and Modifying, and (5) Summarizing and Applying. Findings indicate that connectors with more than one high centrality score are more likely to contribute to Phase III of knowledge construction in MOOC forums. Of particular note, high degree

centrality seems to be integral for Phase III of knowledge construction to occur by these connectors (see *Table 23*). Findings also indicate that high betweenness centrality scores do not correlate with higher phases of knowledge construction. This is interesting because, that seems to contradict what literature suggests in the connectors with high betweenness centrality act as brokers of knowledge. The implications of this suggest that having high betweenness centrality is not enough to influence knowledge construction, and that, perhaps, intervention is needed. This would correspond to what other literature suggests in that instructor intervention is needed to encourage participants central in the network to enable knowledge construction to occur. *Appendix 2* provides an example of how coding was completed for analysing KC phases in the discussion forum transcripts.

The IAM content analysis also identifies possible KC patterns, showing that there are only a few occurrences where connectors play a pivotal role in progressing segments for each KC phase. In most cases, connectors were a part of discussion segments where they engage in the thread but do not dominate or influence knowledge construction. In fact, in most cases, connectors are participants in mixed KC phase segments (See *Table 24*). In other words, while some categories of connectors contribute to the Phase III of knowledge construction, very few are influential in or pivot knowledge construction in the network. These findings are significant because they suggest that, while MOOC learning networks will most likely have connectors who are in a position to be pivotal in knowledge construction, it does not occur. Again, the implications of this are that being central in a learning network does not imply that a participant has impact on knowledge construction.

**Table 23**

*Distribution of Phases of KC for each connector category*

| Phase | degree, between-ness and closeness | degree and closeness | degree and between-ness | Between-ness and closeness | degree | Between -ness |
|---|---|---|---|---|---|---|
| **Phase I** | 9 | 2 | 0 | 10 | 5 | 0 |
| **Phase II** | 7 | 11 | 5 | 2 | 6 | 1 |
| **Phase III** | 0 | 6 | 1 | 2 | 1 | 0 |
| **Phase IV** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Phase V** | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 24**

*Distribution of possible KC patterns for each connector category*

| Pattern | degree, betweenness and closeness | degree and closeness | degree and betweenness | betweenness and closeness | degree | betweenness |
|---|---|---|---|---|---|---|
| **1a** | 0 | 6 | 1 | 2 | 3 | 0 |
| **1b** | 1 | 3 | 1 | 1 | 2 | 0 |
| **2a** | 0 | 0 | 1 | 0 | 0 | 0 |
| **2b** | 0 | 0 | 0 | 1 | 0 | 0 |
| **3** | 5 | 4 | 0 | 2 | 5 | 1 |
| **4** | 0 | 2 | 1 | 8 | 1 | 0 |

The following sections present the findings of the IAM content analysis for each course.

### 4.3.2 Phases of Knowledge Construction for Connectors in Course 1

Seven participants were identified as connectors within the entire network from the SNA results, and an IAM content analysis of their discussion forum contributions across five discussion threads was completed. Based on the social network analysis, there is one participant in each category except in high degree and closeness and high betweenness and closeness, which have two participants each. *Table 25* shows the topic of the threads and the number of posts in each thread. Since there was only one coder, the IAM content

analysis was conducted twice over a one-month period to test coding reliability. Cohen's Kappa statistic was used to evaluate inter-reliability of the coding using the IAM content analysis. The Kappa value was .0659 which suggests moderate reliability.

**Table 25**

*Thread topics and number posts in each thread*

| **Threads** | **Total Posts** |
|---|---|
| What is Culture? | 436 |
| High-Context and Low-Context Cultures | 146 |
| Critically thinking about Hofstede's cultural dimensions theory | 215 |
| Hofstede's cultural dimensions | 259 |
| Granthill Winery Case and Intercultural Issues | 262 |

According to the IAM content analysis, the majority of posts contributed by connectors occurred in phase II (54%), followed by Phase III (24%) and Phase I (22%) respectively. No connector posts were coded at higher phases. Connectors categorized with high degree and closeness centralities contributed most of the posts that occurred in Phase II (55%) and Phase III (67%). One connector categorized with high degree and betweenness centralities contributed 25% of the posts that occurred in Phase II. Connectors categorized with high betweenness and closeness centralities contributed most of the posts that occurred in Phase I (75%). *Table 26* illustrates the distribution of each phase.

**Table 26**

*Distribution of Phases of Knowledge Construction among connectors*

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| **High Degree and Closeness** | | | | | |
| Participant 6118f8 | 1 | 4 | 3 | 0 | 0 |
| Participant db9ae3 | 1 | 7 | 3 | 0 | 0 |
| **High Degree and Betweenness** | | | | | |
| Participant f5d21a | 0 | 5 | 1 | 0 | 0 |
| **High Betweenness and Closeness** | | | | | |
| Participant a8a619 | 2 | 2 | 0 | 0 | 0 |
| Participant c38ce | 4 | 0 | 1 | 0 | 0 |
| **High Degree** | | | | | |
| Participant e80046 | 0 | 1 | 1 | 0 | 0 |
| **High Betweenness** | | | | | |
| Participant Fc91054 | 0 | 1 | 0 | 0 | 0 |
| **Total** | 8 | 20 | 9 | 0 | 0 |

Most of the posts by connectors with high degree and closeness centralities in both Phase II and Phase III are short (1-2 sentences) contributions, focus mainly on identifying, asking negotiating or clarifying ideas, and are one off posts with no other contribution to the threaded discussion. The posts for Phase III are mainly related to negotiation or clarification of the meaning of terms or the negotiation of the relative weight to be assigned

to types of arguments. For instance, in response to previous posts in the forum thread "What is culture?", *Participant 6118f8* asks for clarification of how culture is defined based on geographic areas:

> I agree with you about the combination, but how could you find out the culture could be only based on same geographic area? In my opinion, we might only be possible to know the similar living style or quality in a same geographic area. [Phase III]

In another forum, the same participant negotiates the importance of advice to a problem (names are fictional characters used the learning materials):

> [Participant 6118f8] I agree with you, and I also think that is necessary for Justin to visit where he plans to start the business of exporting. This could also help Justin to have a bright view of points on what you suggested while doing the analyses. [Phase III]

However, *Participant db9ae3*, an identified connector with high degree and closeness centrality, never posted messages that achieved Phase III or above. All of their contributions in this sequence of posts were coded Phase II. This suggests that while a connector with both high degree centrality and closeness centrality may contribute messages that are Phase III, it is not a sufficient condition for it to occur. Yet, this is not in line with Jiang et al.'s (2014) conclusion that MOOC discussion forms are dominated by a small percentage of learners who contribute more than others and, as a result, are the source of opinions and knowledge. While, like Jiang et al (2014), the connector's centrality indicates that they contribute frequently to the forums, there is no evidence that they are a source of opinion and knowledge. Jiang et al. (2014) do note that their data demonstrates mixed results, where

findings from one MOOC course found no relationship between centrality and sources of opinion leaders and knowledge.

The majority of connectors that were coded with Phase I were those with high betweenness and closeness. These connectors mainly answered the discussion prompt provided by the course task, and did not engage or acknowledge other contributors in a thread. For instance, *Participant c38ce* only posted their opinion of what culture is in the thread "What is culture?", but did not attempt to further the discussion with other classmates:

> In my view, culture is something we have inherited from our ancestors. Its the values and behaviour or manners in which we tend to grow and learn the basic etiquette of life. Culture somehow directs or govern our behaviour. If its in our culture to greet people happily and be humble than it will reflect in our behaviour or manners. [Phase 1].

In a similar instance, *Participant a8a619* posted their opinion in a thread about a mini-case "Granthill Winery Case and Intercultural Issues", but did not attempt to further the discussion with other classmates (names are fictional characters used the learning materials):

> I think Justin should visit David Lau and discover Hong Kong together. They seem be connoisseur on their areas but the fusion of both is necessary. Justin and David maybe need assist to some wine fair where taste other wines and offer their own wine. [Phase I]

So far, these findings are consistent with other studies using the IAM in that higher Phases 4 and 5 of knowledge construction rarely occur in online course discussion forums (Wise and Chiu, 2011; Luca et al. 2014). This seems to be no different for xMOOCs. It appears that having high connectivity has little correlation to contributions to higher levels of knowledge construction. However, the findings do suggest that connectors who contribute to Phase III often have at least a high degree centrality score. Considering this, the IAM content analysis of connectors shows that there is little evidence of the identified connectors engaging in: operation interaction, wayfinding interaction, sensemaking interaction, or innovation interaction (Wang et al. 2017). The connectors who did achieve Phase III contributed posts that are mainly related to negotiation or clarification of the meaning of terms or the negotiation of the relative weight to be assigned to types of arguments. One explanation for this may be that participants have little guidance of goal setting for establishing collaborative dialogue with their peers. Instead, it appears as though participants are simply responding to engagement prompts set out by the course instructor and are, for the most part, either ignoring other participants' messages or choosing not to engage in any dialogue. Additionally, connectors seem to follow this conclusion, despite their potential role in the learning network for brokering knowledge transfers and knowledge construction, or the frequency of their posts.

These findings are consistent with Wise and Chiu's (2011) study where they asked: what pattern(s) characterize the KC process during an online asynchronous discussion with assigned roles? According to their findings, most posts were in KC Phase 1. However, Wise and Chiu's findings suggest that participants continued to Phase 3 more than Phase 2,

which does not happen in Course 1 of the study. Reasons for this are likely to be the fact that roles were assigned to participants, encouraging negotiation among participants. This is a significant point to consider with MOOCs as roles have not been assigned to participants, nor are their explicit goals set to encourage participants to negotiate meaning with others in the learning network. Any posts that initiate negotiation or other behaviour that would be categorized as Phase 3 occur only if a participant chooses to do so on their own accord.

Overall, the SNA has identified connectors who are in a position to facilitate collaborative dialogue, share relevant information needed for learning, or negotiate meaning (Haythornthwaite, 2019; Hodgson et al. 2012; Kop, 2012). However, these findings do indicate that participants with high degree centrality or high betweenness scores do not always lead discussion, shape argument, synthesize discussion points, and influence the direction of discussion (Haythornthwaite, 2019; Wise and Chiu, 2011). In contrast, these findings do support previous literature that identifies participants who are active versus passive, observing, or lurking (Hill, 2013; Ramesh el al., 2014; Coffrin et al. 2014, Coffrin et al. 2014).

However, the analysis should not stop here as it would treat connectors' messages in isolation and not as part of the process of knowledge construction. As Wise and Chiu (2011) argue, Gunawardena et al.'s (1997) IAM is meant to be used to analyse the process of knowledge construction. Focusing in single messages contributed by connector's defeats this point. Additionally, it also neglects the possibility that a connector's message may have

an impact on the knowledge construction process. That is, while a connector may not be contributing higher phases of knowledge construction in the discussion forum, that does not mean they are not influencing others who may, as a response (either in part of in whole) to their message, post messages that are higher phases of knowledge construction. In other words, identifying the KC phase of a connectors' message should be the first stage in analysing their role in knowledge construction. There is still a question as to whether their high measures and type of connectivity has an emergent outcome of knowledge construction among the interrelated dialogue among participants.

### 4.2.3 Patterns of KC in sequence of posts for Course 1

To indicate whether the connectors posts were pivotal in influencing knowledge construction in the discussion forums, patterns of KC (e.g. 111**3** →2133) were identified by coding a sequence of posts around the connector's post in each thread. The sequences were then categorized under KC patterns identified by Wise and Chiu (2011). The majority of pattern sequences occurred in KC pattern 1a (29%), followed by KC pattern 3 (26%), pattern KC 4 (26%), pattern KC 1b (16%), pattern KC 2a (3%), and pattern KC 2b (0%), respectively. Connectors categorized with high degree and closeness centralities were found to be main pivotal posters for KC pattern 1a (50%). Connectors categorized with high degree and closeness centralities were also the main pivotal posters for KC pattern 1b (60%), and KC pattern 4 (50%). Connectors with high betweenness and closeness centralities were the main contributors to KC pattern 3. *Table 27* illustrates the distribution of KC Patterns.

**Table 27**

*Participants' contribution to KC Patterns*

| | KC Patterns | | | | | | |
|---|---|---|---|---|---|---|---|
| Participant | 1a | 1b | 2a | 2b | 3 | 4 | Total |
| **High Degree and Closeness** | | | | | | | |
| Participant 6118f8 | 5 | 3 | 0 | 0 | 0 | 0 | 8 |
| Participant db9ae3 | 1 | 0 | 0 | 0 | 4 | 2 | 7 |
| **High Degree and Betweenness** | | | | | | | |
| Participant f5d21a | 1 | 1 | 1 | 0 | 0 | 1 | 4 |
| **High Betweenness and Closeness** | | | | | | | |
| Participant a8a619 | 2 | 1 | 0 | 0 | 1 | 0 | 4 |
| Participant c38ce | 0 | 0 | 0 | 0 | 1 | 4 | 5 |
| **High Degree** | | | | | | | |
| Participant e80046 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| **High Betweenness** | | | | | | | |
| Participant Fc91054 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Total | **9** | **5** | **1** | **0** | **8** | **8** | **31** |

Four main themes appear after identifying IAM sequence patterns. The first is that connectors with high degree and closeness contributed the most to KC pattern 1a. However, their messages were not always identified as the pivotal posts that moved a discussion up in KC phases. For example, *Participant 6118f8* contributed in five posts with

the following sequences: 11<u>2</u> → **3**3222; 12<u>1</u> → **1**2211; 12<u>2</u> → **2**3322; 11<u>2</u> → **2**2211; and 12<u>2</u> → **3**3221 (underline indicates the pivotal message, and bold indicates the connector within the sequence). In most cases *Participant 6118f8* appears to be influenced by a previous post, with the remainder of the sequence progressing at higher phases. For instance, in a sequence (112 → **3**3222) in the discussion thread, "What is culture?", a participant notes differences in defining culture, followed by posts with higher KC by *Participant 6118f8* and others:

> [Participant X] To my opinion, culture may now be regarded as the set of distinctive spiritual, material, intellectual and emotional features that characterize a society or social group. It includes not only the arts, humanities and sciences, ways of life, the fundamental rights of the human being, value systems, traditions and beliefs. [Phase 1]
>
> [Participant X2] Oh of course every nations has own unique culture, belief and traditions.Thanks. [Phase 1]
>
> [Participant X3] As others have said, culture is the combination of values and behaviour between people in a same geographic or economic space. the different values and behaviours makes differents the cultures and they establish the relation between people as friends or family. [Phase 2]
>
> [*Participant 6118f8*] I agree with you about the combination, but how could you find out the culture could be only based on same geographic area? In my opinion, we might only be possible to know the similar living style or quality in a same geographic area. [Phase 3]

[Participant X 4] I believe that both of National and Organisational cultures. I remember that long time ago I came to Russia I was so shocked culture of behaviours people and customs of Russia. It would be " National cultures". When I start to work for mining company they have strict rules and procedures of safety in every office and department. My previous company was not like that and I was so shocked at my new company rules and procedures. Of course, it would be organisational customs. Thank you for your attention. It is always feel free to tell me your opinion on my note. Thank you. [Phase 3]

[Participant X6] Where was your first company based? [Phase 2]

[Participant X6] I have lived many years in Russia and I was surprised by the difference of culture at work or in public compared to culture in private (home or among friends). This made clear the difference between an institutional culture people just follow or have to accept and private culture people really embrace but do not (dare to) expose in public. [Phase 2]

[Participant X6] I'm from Russia and even for Russian people are also not so easy to understand behaviour of some surrounded people. In additional I'd like to make a note that mostly people in Russia are quite smart, intelligent and clever. It depends only on family where child grew. [Phase 2]

In this example, *Participant X2*, who is not identified as a connector, appears to initiate a series of posts at a high KC phase level with their message. Prior messages to *Participant X2* do not exhibit high KC phases. The findings also indicate that the connector (*Participant 6118f8*) directly interacts with the pivotal post, and, as a result posts a message that

achieves a higher level of KC. However, the connectors' post does not act as a pivotal message for the following messages.

The second theme is that connectors with high degree and closeness were also the highest contributors to KC pattern 3. In these instances, the connectors provide a higher KC phase; however, the sequence of posts that follow do not always progress to higher KC. Additionally, most connectors in this sequence are not interacting with their classmates; instead, they are often contributing to a single post in response to the discussion prompt provided by the course. For example, *Participant db9ae3* contributes to the following sequences: 111**2** → 1121; 121**2** → 1122; 122**3** → 2232; and 122**3** → 32**2** → 3**2**. In most cases *Participant db9ae3* is restating a position by referencing to experience, literature or data; however, they are not interacting with others in the sequence of posts. Further to this, the sequence of posts are mostly isolated comments in response to the discussion prompt. For instance, this is a sequence from the thread "Critically Thinking About Hofstede's Cultural Dimensions Theory":

> [Participant X] My country India is a part of High context culture. It could be placed after Greece in the spectrum.
>
> [Participant X2] Hello everyone, I´m from Spain, I also agree with the ranking of countries. I believe that there is a good cultural level, although depending on the area of the country the people have changed a little the way of being. For example: In the North, the people are generally more reserved and serious while people in the South is more lively and funny.

[Participant X3] Where does your country/culture fit in this spectrum? Bangladesh falls between Spain and Italy. Does Hall's categorization of your culture seem valid? Why or why not? To some extent it valid but not much. According to high and low context cultural definition, they are mean much by saying low and say straight forward respectively. Bangladesh people speaks to much but sometime very less. Citizen speak less while they are sad and unhappy with others. But there are case they shout and fight. in such case they talk much. Usually we talk much. One very exceptional thing, in case of bad relationship, we do not talk anything but mean many thing on our silence.

[Participant db9ae3 ] According to the chart, I fit into a high context culture because I belong to an Arab country which is Egypt. Though a high context culture communicates indirectly in different situations, my Upper Egypt part where people have strong sense of traditions and history call a spade a spade. That proves the diversity in one single culture.

[Participant X4] Mexico is 50-50 High and Low context culture, this is because our cultural differences in south and north Mexico. In south for example, people tent to be very polite, talk a lot, is persuasive and often use indirect communication. People in south want make feel you good, they "regulate" the way they communicate, necessities, complains, advices, or when they ask for something, the form is important. In contrast, in north Mexico people tend to be blunt, direct, they do not care the form, what is important is to communicate the idea, sometimes in a discourteous or rude way. In fact many people in north often consider south Mexico people suspicious, or mistrustful, on the contrary south's opinion is that north

people tend to be rude, as if they were always angry or piss. Curious isn't it? Regards :)

[Participant X5] In High Context Cultures relationship is more important than the task. The family is an example of high-context culture. The group of parents who go to meetings of their child's school is also an example. Globally, Japan and Korea are examples of exceptionally high context cultures. In a low-context culture is given much importance to the rules. In these cultures, the task is more important than the relationship and codes, beliefs and customs must be expressed at the beginning so newcomers can interact. An example of low-context culture is the behaviour of people at airport. Globally, the United States is an example of a low-context culture.

[Participant X] I agree with you that my country fromm the Arab countries is a high context culture . The communication style tends to be indirect. We use a lot of words in expressions.

[Participant X6] As Latin American I can't agree more about being a high context culture, though, that will depend of the area, family education and internal culture. Because at least in "my" family, we tend to be a lower context in general but then we change to high context if it is necessary.

It's clear from this sequence of posts that there is very little interaction among participants. The sequence of KC patterns appears to be mixed, which is most likely due to the fact that there is not interaction or dialogue among the participants. So, despite the connector posting a message that exhibits a high KC phase, their message appears to have no impact on the sequence of posts. This may suggest that participants are not reading the sequences of posts, which is consistent with other studies suggesting that MOOC participants often do

not directly interact with other participants (Eynon et al. 2016; Sunar et al. 2017; Tawfik, 2017).

The third theme is that connectors with high degree and closeness were also the highest contributors to KC pattern 1b. In these instances, there appears to be an attempt by the connectors to progress KC in a discussion, yet other participants do not respond or they simply respond to the discussion prompt as part of a course task. For example, *Participant 6118f8* contributed in three posts with the following sequences: 133**2** → 111; 222**2** → 1111; 122**3** → 2211. In all three cases *Participant 6118f8* appears to initiate progression of KC; however, their posts are always followed by a regression of KC patterns. For instance, in the thread "Granthill Winery Case and Intercultural Issues", the connector contributes by negotiating the relative weight to previous arguments, but the following participants regress to stating agreements, opinions and observations:

> [Participant X] I think that Campbell must visit to his intended future market if he wants to be in prosper in lucrative wine market because one cannot get all glimpse of one culture just by reading. [Phase 1]
>
> [Participant X2] I wonder whether there is a well-defined set of role and responsibilities between Justin Campbell of Granthill Winery and David. Justin Campbell may have reasons why he can't but develop this business in distance, maybe much work to do at home, while David, as a serial entrepreneur, may expect more engagement or commitment from Justin by assuming his role as an intermediator by just opening a website and waiting for a potential distributor. They may have different dreams in their minds. What about the more fundamental

question of who will take the risks of the upfront investments of time, money, and efforts mostly with the channel development and marketing promotions particularly at the incubating stage? I experienced that business process and the roles and responsibilities associated could be defined differently in another country. If business practice can also be a part of intercultural issues, this case reveals a serious issue with it. It may be a time for Justin and David to sit together and to confirm their roles and responsibilities, which will eventually help define the business process to follow. [Phase 2]

[Participant X3] First,it is necessary to know Chinese customer taste and need .Second,understanding the differences are the key.There is great difference between western and eastern,such as people,economy and politics.Therefore,deeper understanding local culture on drinking wine is important to break into mainland market. [Phase 2]

[*Participant 6118f8*] More findings about the intercultural between the countries on wine industry is needed. I believe that Justin and others should build up more platforms to communicate instead of only using skype. Also, searching is kinda important in this case before Justin decide whether importing to Hong Kong and China, but not only following the new policy about the tax free of importing wine. This is undoubted that both of them should do more research and analyse those data, and finally make the best decision on whether they should start this business. [Phase 3]

[Participant X4] i strongly agree that to have the business in Asia country you no only need to be professional but the networking is rather important.As Asian care more for the contextual relationship when dealing with business. [Phase 2]

[Participant X5] Justin Campbell should have visited both the Hong Kong and the Chinese market to understand its complications regarding the market and its intercultural differences. Locals and international business partners are essential to have updated and reliable data. [Phase 2]

[Participant X6] I think Justin accepts the David suggestion to visit Hong Kong and Maidland China. If you want to break into a international market, you should really to understand the country's culture. Sometimes, face to face communication will help to reduce the misunderstand and tap into the market. [Phase 1]

[Participant X7] I think Justin should not ignore and underestimate the impact of intercultural difference in develop personal relationship and involvement between business partners. Face to face interaction is the most effective way to build trust and relationship. [Phase 1]

Again, this is likely due to the fact that there is very little or no interaction or dialogue among the participants. This aligns with Tawfik et al.'s (2017) findings, which indicate that learners do not engage in high degrees of co-construction of knowledge. The connectors posting appears to have no impact on the sequence of posts. Again, this may suggest that participants are not reading the sequences of posts, which is consistent with other studies suggesting that MOOC participants often do not directly interact with other participants (Eynon et al. 2016; Sunar et al. 2017; Tawfik; 2017).

The fourth theme is that connectors with high betweenness and closeness were the highest to contribute to KC Pattern 4. In these instances, connectors' posts were mostly Phase 1, having no impact on the KC pattern sequence. For example, the KC pattern 4 sequence for *Participant c38ce* is as follows: 211**1**121; 221**1**222; 222**1**222; and 222**1**122.

As mentioned, these findings support an earlier observation that most connectors are not interacting with their classmates. Additionally, there is no circumstantial evidence to suggest that the connectors contribute pivotal moments for higher phases of knowledge construction to occur. While it seems that connectors with high degree and closeness contribute to KC pattern 1a, their contributions were not always identified as pivotal posts that move discussions up in KC phases. This was evidenced by analysing *Participant 6118f8's* contribution in five posts. As mentioned, connectors are mostly contributing a single post in response to a discussion prompt provided by the course. These findings are relevant because they confirm that connectivity, whether as having high degree or betweenness centrality, has no correlation with influencing the process of knowledge construction. Although, these participants are positioned in the learning network to be connectors and adopt the role of supporting knowledge construction because of their relational ties, their actual behaviour indicates that they do not follow through on that role.

There are a few interpretations for these findings. From the perspective of complex systems, conditions that influence interaction among agents to predict or enable emergence need to be present (Mitchell 2009). First, there is little incentive for participants to develop strong relational ties with others or to form groups that enhances the possibility

for co-construction of knowledge in a MOOC. Goggins and Galyen (2016) and Tawfik et al. (2017) note that small group formation can encourage learner-learner interactions for knowledge construction to occur in xMOOCs. If there is no incentive for xMOOC participants to form small groups, then knowledge construction as an emergence is unlikely to occur. Second, there are no clear guidelines in the course telling the participants to comment on others' posts. The discussion prompts simply asks a question in relation to a problem and instructs participants to post their response. Again, there is no incentive for the participant to engage with another despite being a connector or not. Finally, there is no guidance or instructions for participants to consider what they discussed in one discussion thread could inform the dialogue in another. Complexity theory (Mitchell, 2009) posits that self-organization and emergence needs consistent rules to define how components interact in order for it to occur. The assumption that roles will emerge spontaneously by xMOOC participants (Gašević at al. 2019) is unlikely.

Furthermore, these findings indicate that having high centrality scores does not mean that a participant is a broker of knowledge, or at least one that is pivotal in the facilitating knowledge transfer and construction in the learning network. And, participants identified as connectors do not seem to have the attributes defined by literature (Dawson, 2008; Gladwell, 2000; Hansen, 1999; Levin and Cross, 2004; Jiang et al. 2014; Kotowski and dos Santos, 2010; Nichani and Hung, 2002). For example, they do not serve a key function in bridging borders between other participants or broker knowledge transfer.

Additionally, although connectors have been identified and defined based on their connectivity in the learning network, they do not appear to take up any particular roles. This seems to contradict the assumption that roles will emerge spontaneously by group members without the interference of teachers (Gašević et al. 2019). Or if roles do emerge, there does not seem to be any correlation to high measures of connectivity. Connectors do appear to focus their posts on content related tasks, which are similar results to Gašević at al. (2019). The results also show that participants' actions are interdependent based on the patterns of knowledge construction findings.

These findings also support claims by scholars who are sceptical of xMOOCs that most designs lack collaborative learning opportunities (Goodyear 2014). As Wise and Chiu (2011) note, the underlying premise of Gunawardena et al.'s (1997) theoretically proposed patterns of knowledge construction is "that groups construct knowledge through a specific sequence of phases". This is also supported in other literature on collaborative knowledge construction. For example, Onrubia and Engel (2009) and Wise and Chiu (2011). Because there are not assigned roles or set goals in the instructional design that would encourage contributions of higher phases, it's unlikely that the identified connectors and other participants have any reasons to interact with other participants, or the reverse. Findings from this study do suggest that Pattern 1a does occur, which indicates some level of collaborative dialogue does occur in the MOOC learning network. However, the identified connectors do not contribute pivotal posts that enable that pattern to occur, which suggests that social ties (weak or strong) are not essential. Wise and Chiu's (2011) findings also suggest that a high occurrence of Pattern 3 provides evidence that participants don't

engage in “a shared mode of interaction”. This is supported in findings from the first course that the identified connectors are often not interacting with their classmates; instead, they are contributing to a single post in response to the discussion prompt provided by the course.

Overall, the findings from Course 1 indicate that the identified connectors are not having any meaningful impact on the process of knowledge construction in the MOOC learning network. At best, they occasionally contribute higher phases of knowledge construction with little observable influence on other participants or patterns of knowledge construction that follows their messages. This seems to be consistent regardless of a connector’s category, such as degree centrality, betweenness centrality or some form of combination. This seems to reinforce Wise and Chiu’s (2011) suggestion that intervention is needed for knowledge construction to occur. It cannot be assumed that the possible opportunities for connectors to impact knowledge construction due to their connectivity automatically means they will adopt roles that initiates knowledge construction. Considering this, intervention could come from the MOOC instructor; however, given the number of participants’ messages, this seems unlikely.

### 4.3.4 Phases of Knowledge Construction for Connecters in Course 2

#### *Course 2*

This section reports on the IAM content analysis findings from Course 2, including the identification of KC patterns, based on results from the social network analysis used to

identify connectors in the entire network. As mentioned, the IAM content analysis was used to address the second research question: How do these connectors support knowledge construction in the discussion forums? Two participants that were identified in the SNA to be connectors were excluded from the IAM content analysis: *Participant d5a7fd* because they posted links to voice recordings at third-party websites which were no longer available at the time of this research; and *Participant dbca728*, who only posted in the discussion forum "Introduce Yourself" and did not contribute any knowledge construction for the remainder of the course. Five participants were identified as connectors within the entire network from the SNA results, and an IAM content analysis of their discussion forum contributions across eight discussion threads was completed. *Table 28* shows the topic of the threads and the number of posts in each thread. Since there was only one coder, the IAM content analysis was conducted twice over a one-month period to test coding reliability. Cohen's Kappa statistic was used to evaluate inter-reliability of the coding using the IAM content analysis. The Kappa value was 1.003711 which suggests high reliability.

**Table 28**

*Thread topics and total posts for Course 2*

| Threads | Total Posts |
|---|---|
| HOFSTEDE'S CULTURAL DIMENSIONS | 60 |
| CRITICALLY THINKING ABOUT HOFSTEDE'S CULTURAL DIMENSIONS THEORY | 59 |
| HIGH-CONTEXT AND LOW-CONTEXT CULTURES | 32 |

| | |
|---|---|
| GRANTHILL WINERY CASE AND INTERCULTURAL ISSUES | 63 |
| WHAT IS CULTURE? | 159 |
| SWOT and TOWS analysis for the Granthill Winery | 44 |
| WHAT ABOUT YOUR CULTURE? DOES IT CHANGE? | 116 |
| THE ROLE OF CULTURE IN ONLINE COMMUNICATION | 64 |

### *IAM content analysis*

According to the IAM content analysis, the majority of posts contributed by connectors occurred in phase II (50%), followed by Phase I (38%) and Phase III (12%) respectively. No connector posts were coded at higher phases. Connectors categorized with high degree centrality contributed the most posts that occurred in Phase II (60%), Phase I (55%). One connector categorized with high degree, betweenness and closeness centralities contributed to the most posts that occurred in Phase III (67%), and second most of Phase II 40%. *Table 29* illustrates the distribution of each phase. Findings for Course 2 are similar to Course 1 in that no participants contributed to higher phases of knowledge construction. This seems to corroborate the suggestion that high connectivity has little correlation to producing higher levels of knowledge construction.

**Table 29**

*Distribution of Phases of Knowledge Construction among connectors for Course 2*

| **Participant** | **I** | **II** | **III** | **IV** | **V** |
|---|---|---|---|---|---|
| High degree, betweenness and closeness | | | | | |
| Participant: 4742a0 | 0 | 4 | 2 | 0 | 0 |
| Participant: d5a7fd | 4 | 7 | 1 | 0 | 0 |
| High betweenness and closeness | | | | | |
| Participant 60bd693 | 3 | 0 | 0 | 0 | 0 |
| Participant 090d6e | 1 | 0 | 1 | 0 | 0 |
| High degree | | | | | |
| Participant 0786ec | 3 | 3 | 0 | 0 | 0 |
| Participant 860e5d | 2 | 3 | 0 | 0 | 0 |
| Total | 13 | 17 | 4 | 0 | 0 |

Most of the posts by connectors with high degree centralities in Phase I and Phase II are responses to previous posts. Phase I posts are short (1-2 sentences) contributions, focusing mainly on identifying, and complementing, Phase II posts are longer (2-3 sentences) contributions, focusing mainly on agreeing or disagreeing. For instance:

> [Participant 0786ec] I disagree the first sentence.From my country's history,the culture or we can say it belief originated in the point of a better reign.The upper-

class indoctrinate the poor by culture,making them be placid.My country ever had a boom of different culture 5000 years ago.At that time,there were more than 200 small counties!As the Qin Dynasty expanded by wars and united the country,hundred cultures contending transformed into one culture,Confucius,which is a good method to govern.Dominance and submission,mastery and servitude-such concepts form the basic of feudalism dynasty in Chinese history.**So out of the men's interest,then the culture come into being.** [Phase II]

The posts for Phase III are mainly related to negotiation or clarification of the meaning of ideas. For instance:

[Participant 4742a0] I wouldn´t say it better. I have travelled the world and while working I have met numerous nationalities, there were times we were 40+ nationalities working together. Also from some behaviour I could say who is who, there are some guidelines to guess the nationalitiy. Frameworks are good, but only in general. There are some other aspects which people should bare in mind, as said above. I would say that problem of today is labeling things, people and even cultures...we just give a label (create a Framework) and that´s it. People should go deeper...and not to put the Framework right away..doesn´t mean that somebody is from there...so that he has to be like that.. Other thing is in companies...there some frameworks can give guidelines to what to do to help meet the standards of company... [Phase 3]

### 4.2.3 Patterns of KC in sequence of posts

As with Course 1, to indicate whether the connectors posts were pivotal in influencing knowledge construction, KC patterns (e.g. 111**3** →2133) were identified by coding a sequence of posts around the connector's post in each thread. The sequences were then categorized under KC patterns identified by Wise and Chiu (2011). The majority of pattern sequences for Course 2 occurred in KC pattern 3 (43%), followed by KC pattern 4 (24%), KC patterns 1a and 1b (14% each), pattern KC 2b (4%), and pattern KC 2a (0%), respectively. Connectors categorized with high degree were found to be main pivotal posters for KC pattern 1a (100%) and 1b (67%) and the second highest contributors for Pattern 3 (44%). Connectors categorized with high degree, betweenness and closeness centralities were the main pivotal posters for KC pattern 3 (56%). Connectors with high betweenness and closeness were the main pivotal posters for KC pattern 4 (80%). *Table 30* illustrates the distribution of KC Patterns.

**Table 30**

*Participants' contribution to KC Patterns for Course 2*

| | IAM Sequence Patterns | | | | | | |
|---|---|---|---|---|---|---|---|
| Participant | 1a | 1b | 2a | 2b | 3 | 4 | Total |
| High degree, betweenness and closeness | | | | | | | |
| 4742a0 | 0 | 1 | 0 | 0 | 5 | 0 | 6 |
| *d5a7fd* | 0 | 2 | 0 | 0 | 6 | 4 | 12 |
| High betweenness and closeness | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *60bd69* | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| *090d6e* | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| High degree | | | | | | | |
| *0786ec* | 2 | 0 | 0 | 0 | 2 | 0 | 4 |
| *860e5d* | 1 | 2 | 0 | 0 | 2 | 1 | 6 |
| Total | 3 | 5 | 0 | 1 | 15 | 9 | 33 |

Three main themes appear after identifying IAM sequence patterns. The first is that connectors with high degree centrality contribute the most posts in discussion forum threads and are a part of multiple KC patterns (1a, 1b, 3 and 4). Their contributions never provide messages that achieve KC beyond Phase 2, tend to be a part of the sequence in that they are responding to previous participants, and are often found towards the end of a threaded discussion. Additionally, and, perhaps, more importantly, they rarely provide messages that are pivotal in influencing KC in a discussion thread. For example, *Participant 0796ec* contributed in six posts with the following sequences: 2211**2** → 221 (pattern 1b); 1111**1** → 212 (pattern 1a); 211**2** → 1 (pattern 4); 2321**1** → 1 (pattern 4); 111112**1** → 2221 (pattern 3); 222**2** → 2 (pattern 4). For instance, in the thread titled "Granthill Winery Case And Intercultural Issues" (KC pattern 111112**1** → 2221), *Participant 0796ec* interacts with others by adding additional praise to a participant's idea:

> [Participant X1] First of all, there was a difference of Geographies i.e. continent. One from Asian Continent and another from an American continent. Also, another point of difference was of background. Justine was an entrepreneur whereas David was a trader. Third and most important is, the culture of approaching potential customers.

Where David's culture require personal meeting and developing personal rapport, Justine felt, connecting on skype can serve the purpose. From the case, it seems that doing business is more important for Justine than David. Hence, Justine should rather focus on understanding the culture of Hongkong and Mainland China, Urban as well as Rural. This would act as a stepping stone to understand the Chaina markets. [Phase 1]

[Participant X2] Nicely said :-) [Phase 1]

[Participant X3] I am totally online with your position! [Phase 1]

[Participant X4] Brilliantly. [Phase 1]

[Participant X5] Very good! [Phase 1]

[Participant X6] Excellent understanding!! If I was Justin, I'd rather adapt myself for the eastern culture, specially the Chinese one. Because they have a very traditional culture and habits, and they stay for too long isolate from the west, that could be more difficult for them to understand the western way for doing business. On the other hand, as you just said, it seems that doing business is more important for Justine than David [Phase 2]

[*Participant 0796ec*] Brilliant. Accurate. [Phase 1]

[Participant X7] First of all, there was a difference of Geographies i.e. continent. One from Asian Continent and another from an American continent. Also, another point of difference was of background. Justine was an entrepreneur where as David was a trader. Third and most important is, the culture of approaching potential customers. Where David's culture require personal meeting and developing personal rapport, Justine felt, connecting on skype can serve the purpose. From the case, it seems that

doing business is more important for Justine than David. Hence, Justine should rather focus on understanding the culture of Hongkong and Mainland China, Urban as well as Rural. This would act as a stepping stone to understand the Chaina markets. [Phase 2]

[Participant X8] Hello, my name is Pedro. It is not a good idea to copy the work from a peer, this is called plagiarism. Try it again by yourself, please. All the best. [Phase 1]

[Participant X9] Anyway,we hope that different idea here,and have a contradiction. [Phase 2]

[Participant X10] Ther is a lot of an intercultural issues to be considered to achieve a popularity in the Mainland Chinese market such as the drinking habits , in rural areas consumers in China preferred traditional rice wine and still accounting for more than 50% of the total volume of wine purchased in the country but also he should consider those young urban consumers were increasingly open to purchasing grape wine also Chinese red wine consumers preferred less acidic, sweeter fruit flavors in their red wines and he must be aware of some cultural differences in the business relationship with his partner culture background from Hong Kong they prefer personal involvement from both parties [Phase 1]

This sequence of posts suggests that no KC phase dominates the discussion. *Participant 0796ec* shows an agreement with others in that a previous message was "good". However, the participants' posts that follow begin to discuss new ideas unrelated to the previous messages. In this case, there is some evidence of interaction among participants, but the interactivity does not seem to influence the group towards higher phases of KC. What is

also evident is that the connector, *Participant 0796ec*, does not contribute anything considered pivotal towards knowledge construction. Additionally, *Participant 0796ec's* contribution to the other sequence of messages seem to occur mostly in Pattern 4. This would suggest that the "discussion[s] without any shared mode of interaction, i.e., sequences of posts do not affect one another" (Wise and Chiu, 2011).

The second theme is that the only connector with high degree, betweenness and closeness centralities participated mainly in KC Pattern 3. They never dominate the conversation, don't influence interactions in the discussion thread, and don't progress or regress KC. Typical KC patterns are: 121**2**211; 121**2**2121; 112**2**11211**3**22. For instance, in the discussion thread "Critically Thinking About Hofstede's Cultural Dimension Theory", *Participant 4742a0* progresses KC with their response to a previous post; however, subsequent posts show little interaction with what was said:

> [Participant X] We did a ton of brainstorming for the new business and eventually we had enough ideas to create our proposal which would serve as the framework for the new company. An operational framework is a guide to a company's policies, goals, standards, procedures and training. The framework sets out the way the company does business and promotes a corporate culture and identity. An operational framework may also include principles of good governance and set out company values and divisions within the firm. Each operational framework contains different elements. A business model describes the rationale of how an organization creates, delivers, and captures value (economic, social, or other forms of value). The process of business model construction is part of business strategy and the design of

organizational structures. Thus the essence of a business model is that it defines the manner by which the business enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit: it thus reflects management's hypothesis about what customers want, how they want it, and how an enterprise can organize to best meet those needs, get paid for doing so, and make a profit. [Phase 1]

[Participant X2] Excellent arguments. I have a poor experience on intercultural business world (a 6-months internship in france), and your explanations will help me a lot to understand some concepts and even how to behave on a business context [Phase 2]

[Participant X3] Personally I haven't traveled other countries yet, but for me this theory is adequate because I met people with different nationalities, of course they grew from different cultures so it is important to communicate with them for them to feel that they are welcome and they are being understood here. and another for them to share to their own cultures and same us me. [Phase 2]

[Participant X4] I feel Hofstede's cultural dimensions theory is adequate from my experience. I have traveled to numerous countries and was able to culturally scratch the surface on some and dig deeper others. I could roughly tell you which country was which if I went down Hofstede's list. The disadvantage of using these theories and frameworks is that it only provides a baseline. In a globalized world you can meet people from all walks of life. A friend of mine is a Korean gentlemen who was raised in Indonesia and attended an international (English speaking) school. I couldn't just look at his family name and start preparing to do business with

someone born in Korea. Many of the world's biggest cities are now cosmopolitan. I attend an international church in Vietnam and there are 50+ nationalities represented. Dig a little deeper before labeling a future business contact under the Hofstede's framework. Ask a few questions and discover the person's background. After you gathered some clues, then try to apply it to the framework. [Phase 3]

[*Participant 4742a0*] I wouldn´t say it better. I have travelled the world and while working I have met numerous nationalities, there were times we were 40+ nationalities working together. Also from some behaviour I could say who is who, there are some guidelines to guess the nationalitiy. Frameworks are good, but only in general. There are some other aspects which people should bare in mind, as said above. I would say that problem of today is labeling things, people and even cultures...we just give a label (create a Framework) and that´s it. People should go deeper...and not to put the Framework right away..doesn´t mean that somebody is from there...so that he has to be like that.. Other thing is in companies...there some frameworks can give guidelines to what to do to help meet the standards of company... [Phase 3]

[Participant X5] I am completely agree with you [Participant X4]. My internacional experiences have shown me that there aren't so much cultural border for a international business. [Phase 2]

[Participant X6] Culture is a term difficult to describe, so for me, any definition brings us closer to construction a real explanation about what culture is it. The framework written for both theories show us the multiples dimension that we have that we consider exploring the culture. Maybe, we lack research more about how

that dimension interacts with them or find new dimension or a new point of view about culture. [Phase 2]

[Participant X7] I think Hoftsede's cultural dimensions are very adequate and precise, but a little confusing, I had to read them many times to understand them. Advantages: it gives me a general framework about cultures and behaviours. Disadvantages: culture is volatile, so it is very difficult to just consider these dimensions. [Phase 1]

In this case, there are several KC phases, but none dominate. There appears to be some acknowledgement of previous messages, with some participants indicating agreement or disagreement with the content. However, the dialogue never progresses towards higher phases of KC after *Participant 4742aO's message*. Instead, *Participants X6* and *X7* contribute posts that seem to ignore anything previously discussed, indicating that there is little shared mode of interaction. These findings are consistent to findings in Course 1 and align with literature that states there is very little learner-learner interaction in xMOOC discussion forums (Eynon et al. 2016; Sunar et al. 2017; Tawfik; 2017).

The third theme is that connectors with high betweenness and closeness centralities participated mainly in KC Pattern 4. These connectors rarely post above Phase I, having no impact on the KC pattern sequence. For example, the KC pattern 4 sequence for *Participant 60bd69* is as follows: 111**1**211; 111**1**111; 1**1**11211. This implies that there is no interaction among the participants, despite connectivity or centrality measures.

Findings from Course 2 have some correlation to findings in Course 1. In particular, Course 2 findings also indicate that most connectors are not interacting with their classmates. In fact, there appears to be little interaction among all participants. Again, there is no circumstantial evidence to suggest that the connectors contribute pivotal moments for higher phases of knowledge construction to occur. Additional, connectors in Course 2 are also following the behaviour that they are mostly contributing a single post in response to a discussion prompt provided by the course. As mentioned earlier, these findings are relevant because they confirm that connectivity, whether as having high degree or betweenness centrality, has no correlation with influencing the process of knowledge construction. Furthermore, it indicates that having high centrality scores do not mean that a participant is a broker of knowledge, or at least one that is pivotal in facilitating knowledge transfer and construction in the learning network. For example, they do not serve a key function in bridging borders between other participants or brokering knowledge transfer.

Overall, the findings from Course 2 indicate that the identified connectors are not having any meaningful impact on the process of knowledge construction in the MOOC learning network. At best, they occasionally contribute higher phases of knowledge construction with little observable influence on other participants or patterns of knowledge construction that follows their messages. This seems to be consistent regardless of a connector's category, such as degree centrality, betweenness centrality or some form of combination. This seems to reinforce Wise and Chiu's (2011) suggestion that intervention is needed for knowledge construction to occur. It cannot be assumed that the possible

opportunities for connectors to impact knowledge construction due to their connectivity automatically means they will adopt roles that initiates knowledge construction. Considering this, intervention could come from the MOOC instructor; however, given the number of participants' messages, this seems unlikely.

Regarding roles, findings from Course 2 support the finding in Course 1 that, although connectors have been identified and defined based on their connectivity in the learning network, they do not appear to take up any particular roles. This is an interesting contrast to Jiang et al. (2014) who indicate discrepancies in findings between cases. As mentioned earlier, their findings show centrality influenced knowledge construction in one case, but not the other. While their study does not explain those differences, findings from both courses in this study support the argument that centrality has no correlation for influencing knowledge construction.

## 4.3 Addressing the Research Questions

This study began by exploring the problem of how researchers or practitioners might identify participants as connectors, who are central to a learning network and, whether they have a role in influencing knowledge construction in the discussion forums. As noted, literature suggests connectors with certain social ties, such as those acting as knowledge brokers, can increase social capital in the network and, as a result, enable opportunities for knowledge construction to occur. This section summarizes whether the initial research questions were addressed.

### 4.3.1 What are the categories of connectors that emerge from participants' social ties in an xMOOC?

The goal of the first research question is to identify possible categories of connectors that might emerge because of social ties in an xMOOC. A review of literature indicates that there are no clear roles that participants adopt in MOOC learning networks. Some researchers have suggested that roles are spontaneously emergent through outcomes of social ties (Gašević et al. 2019). This seems to be supported by related research of social networks, which suggest connectors, agents who have high centrality measures, often adopt the role of "brokers", "gatekeepers" or "mavens" of knowledge (Jiang et al. 2014). Some studies suggest that MOOCs provide an opportunity for learning communities to emerge and that participants with central roles facilitate knowledge construction (Palcios et al. 2020). However, the empirical evidence for this occurring in MOOCs as a learning network is lacking to make a generalization across all xMOOCs. Roles that have been identified in MOOC literature are often related to frequency of posts (e.g. active participant, lurker, and passive participant), but not actual learning outcomes.

This study began by identifying the research problem that not enough is known about how or whether KC as a learning outcome is achieved in xMOOCs as a learning network or complex system. As mentioned, there is a lack of empirical evidence that knowledge construction occurs in xMOOC, and the literature that does analyse how social or relational ties in learning networks impact knowledge construction is limited in scope. There is some

discussion that centrality, highly connected participants in the learning network, are gatekeepers or "brokers" that influence the flow of information in the learning network. These "connectors" are in positions that enable the emergence of knowledge construction as the result of interactions with other participants in xMOOC as complex systems (Morrison 2008; Mitchell 2009). In other words, a connector's social relations can influence emergence. For example, betweenness refers to actors in a social network that "control or mediate the relations between pairs of actors that are not directly connected" (Carolan, 2014). This is similar to what Gladwell (2000) defines as "connectors" and "mavens".

Meanwhile, studies on general online learning, have shown that roles have an impact in learning outcomes; however, some form of intervention is often needed for roles to be adopted by students (Wise and Chiu, 2011). Other scholars of online learning suggest that network positions and roles that people might have within a learning network can be identified through conducting social network analysis (Haythornthwaite, 2019). Literature on SNA and knowledge construction suggests that centrality measures and social ties may have an impact on who is influencing knowledge construction in the discussion forums. This was also assuming an agent-based modelling approach that suggests that the outcomes of individual MOOC participants' behaviour are interdependent. Considering this, this study used a SNA approach to analysing the discussion forum connectivity by identifying the degree centrality, betweenness centrality, and closeness centrality scores.

In view of this, this study considered similar points outlined by Gašević et al. (2019), in that a connector's possible involvement in knowledge construction can be influenced by:

- the structure of social network ties within collaborative discourse,
- the students' role in group communications with collaborative discourse, and
- collaborative discourse based on identification of high and low-achieving communities of learners.

This study also considered that there are three levels in which roles may emerge (Gašević et al., 2019):

- Micro, where the role is related to a specific task focused on a collaborative process or product
- Meso, where the role involves a pattern of several tasks focused on process, product and their combinations, and
- Macro, where a role is determined by a stance composed of an individual's participation strategy.

Examples of macros roles may be, communicative learners, silent learners, intermittent talkers, concentrated listeners. By identifying the connectors, it is believed that this study can explore the qualitative data to determine whether knowledge construction occurs and how. Findings from the social network analysis indicate that there are identifiable MOOC participants who position themselves within the learning network, enabling them to have an impact on the sequence of knowledge construction in discussion forums.

The categories of connectors that emerged from the social network analysis are: (1) high degree, betweenness and closeness centralities; (2) high degree and closeness centrality; (3) high degree and betweenness centrality; (4) high betweenness and closeness centrality; (5) high degree centrality; and (6) high betweenness centrality. As the literature on social

network suggests, these connectors' social ties enable potential opportunities for knowledge transfer and construction to occur. For example, participants with high degree, betweenness and closeness centralities should, in theory, emerge with the role of 'bridging' others in the network. Because they are affiliated to other participants through their high discussion forum participation, potentially providing weak ties among groups of participants, and, through affiliation, are closely linked to most participants, there is a high probability that they can act as "brokers" of knowledge transfer and knowledge construction. This, of course, is assuming their social ties allow for collaborative discourse to occur and that they play a large role in group communication. This brings into question levels of analysis within a complex system (individual participant; group formation; and whole network), which will be discussed in the next chapter.

The differences among the six categories are mainly differences in measurements of centrality. This distinction is important because a connector's centrality profile may influence how collaborative dialogue and the process of knowledge construction within the learning network occurs. As mentioned, meaning-making and collaboration may be inhibited in online forums due to participants' knowledge of others' social and knowledge background and the social ties they have, whether strong or weak (Oztok et al., 2013). For example, a connector with only high betweenness is in a position to take on a role that establishes weak ties among participants. This enables knowledge transfers to occur among MOOC participants within the discussion forum. And, as a result, high levels of KC phases may occur. For example, a connector with this role is in a position to identify areas of agreement or overlap among conflicting concepts (Phase III), or summarize agreements

among participants (Phase V). However, the reach on the wider learning network may not be as wide if this connector has a low degree centrality score. As a result, the sequence of knowledge construction may be limited to a small cluster of participants.

In contrast, a connector with high degree centrality and closeness may take on the role of building strong ties with participants. Identifying participants with strong ties can help researchers better understand participants' engagement. As Garrison (2016) argues, a MOOC participant may not take the opportunity to engage in critical discourse and contribute to thinking and learning because they do not feel strong connection, loyalty or responsibility to other members of the network. As the review of literature also suggests, strong ties may hinder diversity of opinions in a group (Chen and Huang, 2019), but they also build trust among the engaged participants and are essential for learning to occur (Goodyear et al., 2004). A connector with this role is in the position to explore dissonance or inconsistency among those engaged in dialogue (Phase II) and negotiate meaning of knowledge (Phase III). However, it may be more difficult for them to facilitate higher phases of knowledge, such as applications of new knowledge (Phase V) due to a lack in diversity of dialogue. As mentioned earlier, strong ties, such as "interpersonal bonds and personal goals, could limit communication and weaken cohesive group behaviour" (Garrison, 2016). Considering this, the relations and connections among participants can influence both quality and quantity of knowledge construction and sharing (Chiu et. al, 2006; Oztok et al., 2013). In contrast, participants with strong ties may play the role of answering other participants' questions and assist with the understanding of knowledge (Sinha, 2014b) as they often focus on specific topics in the discussion forum (Gašević et al.,

2019). Shen et al. (2008) study uses SNA to explain how interaction influences sense of community of students in online learning environments, to "show that interaction is strongly associated with students' perceived sense of community."

### 4.3.2 How do these connectors support knowledge construction in the discussion forums?

Based on the findings, it appears that connectors have a minimal, if any, role in supporting knowledge construction in the MOOC discussion forums. This seems to contradict Jiang et al.'s (2014) suggestion that highly connected participants will spontaneously adopt roles in the discussion forum, and supports the suggestion (Garrison, 2016; Wise and Chiu, 2011) that a form of intervention is needed to initiate collaborative dialogue and higher phases of knowledge construction. In fact, findings from this study align with Kanuka and Anderson (2007, p. 12) in that participants' messages are often left "unchallenged, and changes of topic focus and concepts were not negotiated as they would be in a conversational language." As a result, what appears is a thread of nonfluid and nonsequential discussion where participants' ideas in their messages are not challenged, expanded upon, synthesized, or applied in new contexts. This occurs despite attempts by a connector to engage in dialogue, or having social ties in the discussion forum. This suggests that knowledge construction as an observable strand of learning in xMOOCs is not influenced by connectors. This calls into question whether similar manifestations of learning (i.e. knowledge construction) exist in xMOOCs. Why this occurs in an xMOOCs in comparison to smaller online courses is likely due to the design and scale of the courses. As mentioned

earlier, the lack of learner communities forming in xMOOCs is one reason (Goggins and Galyen, 2016; Tawfik, 2017).

Eynon et al. (2016, p. 6) suggest that removing participants who consistently contribute to the discussion forums "would rapidly eliminate the potential of discussion and information flow between other participants". However, this study's findings suggest that removing connectors may have little effect on participant-participant interactions, and, as a consequence, no impact on knowledge construction. It has been argued that when a connector has high degree and betweenness centrality, they will play a pivotal role in knowledge transfer among participants. Yet, the IAM content analysis of Courses 1 and 2's sequential posts involving connectors suggests otherwise. In fact, it would appear that removing the connector may have no impact on knowledge construction.

There may be a few reasons for this. One hypothesis, based on Kanuka and Anderson (2007), is that the anonymity and asynchronous nature of discussion forums makes it easier to ignore participants' messages. A connector's social ties is based on the frequency and breadth of messages across discussion threads, placing them in a position to engage in collaborative dialogue, but that does not necessarily guarantee that other participants will reply and engage in dialogue with them. In contrast, it does not mean that the connector is always engaging other participants; they may simply be "superposters" (Wise and Cui, 2018a).

Wise and Cui (2018a) refer to literature that suggests "superposters", participants with high centrality measures in a MOOC, are often associated with high quality discussion thread posts. While their study did not investigate the influence of learners who have high centrality within the learning network, they do suggest that "superposters" can have an impact on learning outcomes. This is similar to the concept of "super connectors", who have more power in the network because they have access to many resources and these participants are likely to play a key role in the discussion forums (Schreurs et al., 2019). Findings from this study, however, indicate that connectors who contribute "high quality" messages (i.e. Phase 3) or are "super connectors" have no impact on the dialogue that follows. This appears to contradict Wise and Cui's (2018a) study, which suggests that participants' engagement in content related discussion threads develops strong ties and that conversations are likely to be in greater depth. For example, in Course 2, *Participant 4742a0* is attempting dialogue, but other participants do not reciprocate:

> [Participant 4742aO] I wouldn´t say it better. I have travelled the world and while working I have met numerous nationalities, there were times we were 40+ nationalities working together. Also from some behaviour I could say who is who, there are some guidelines to guess the nationalitiy. Frameworks are good, but only in general. There are some other aspects which people should bare in mind, as said above. I would say that problem of today is labeling things, people and even cultures...we just give a label (create a Framework) and that´s it. People should go deeper...and not to put the Framework right away..doesn´t mean that somebody is from there...so that he has to be like that.. Other thing is in companies...there some

> frameworks can give guidelines to what to do to help meet the standards of company... [Phase 3]
>
> [Participant X5] I am completely agree with you [Participant X4]. My internacional experiences have shown me that there aren't so much cultural border for a international business. [Phase 2]
>
> [Participant X6] Culture is a term difficult to describe, so for me, any definition brings us closer to construction a real explanation about what culture is it. The framework written for both theories show us the multiples dimension that we have that we consider exploring the culture. Maybe, we lack research more about how that dimension interacts with them or find new dimension or a new point of view about culture. [Phase 2]

One explanation for this is the asynchronous nature and anonymity of the discussion thread. The participants are doing what they are asked to do: answer the discussion prompt. The connector's high connectivity has not been made explicit to anyone, giving little reason for them to build strong social ties. This supports Garrison's (2015) argument that xMOOC participants do not take the opportunity to engage in critical discourse and contribute to thinking and learning because they do not feel strong connection, loyalty or responsibility to other members of the network. In relation to self-organizing network effects, there is evidence of preferential attachments, but no evidence of reciprocity or transitivity, which are necessary emergent effects in learning networks for collaborative dialogue and knowledge construction to occur (Schreurs et al., 2019).

Another explanation is that knowledge construction can occur as a result of a connector's message, but it is not made explicit in the collaborative dialogue of the discussion thread. As Kanuka and Anderson (2007, p. 15) note:

> It may also be possible that the construction of knowledge is not an observable activity. For example, participants may have been reflecting on the issues presented in the forum, resulting in the construction of knowledge that was not shared with other participants.

In the above example, *Participant 4742a0*'s message appears to be ignored by the other participants and an explicit sequential pattern of knowledge construction does not appear. However, what is not observable is each participants' internal cognitive process of knowledge construction after reading the discussion thread. On the surface, the sequence of posts involving a connector appears to be nonfluid. Because of this, it cannot be said with certainty that a connector's role in supporting knowledge construction is pivotal or not pivotal. For example, the connector may not pivot the discussion towards a high level of knowledge construction, but that does not mean their message does not play a supportive role for other participants.

This brings up an important issue: whether roles spontaneously develop in xMOOCs. Haythornthwaite et al. (2019, p. 256) suggest that: "Information brokers, technological gurus and others who monitor and bring knowledge into a network help direct it to appropriate receivers as well as select what appears relevant to the network and its learning needs". While the findings suggest that connectors do not play a pivotal role supporting knowledge construction, it should not be assumed that they do not play a role

at all. For example, the connector may not lead the discussion; however, the self-organizing effect of connectors' preferential attachments does increase connectivity and the sharing of information, and, as a result, can implicitly shape other participants' contributions without reciprocity occurring. In this sense, there is no brokering among participants; instead, a connector is distributing their knowledge across the network via their frequent posts.

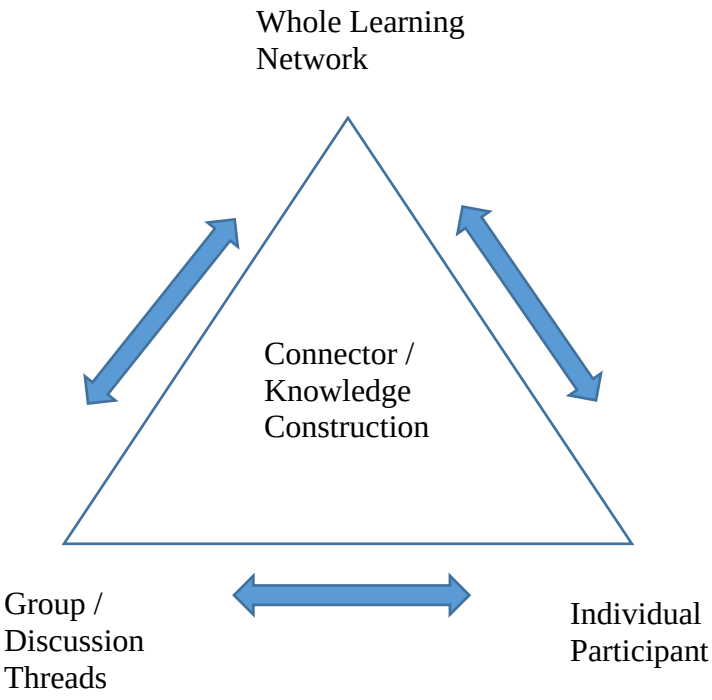
The findings from this study indicate there is a lack in strong ties between connectors and other participants because reciprocity or transitivity do not occur as self-organized emergent properties, which suggests intervention or new design thinking is needed. Wise and Chiu (2011) argue that in order for higher phases of knowledge construction (Phases 4-5) to occur in smaller courses, roles need to be explicitly made by the instructor. This is not surprising and is noted by Goodyear (2014), who posits that xMOOCs are generally designed in a way that encourages unidirectional connections from the lecturer to the students, with little opportunity for students to engage in other connections. Due to the scale of MOOCs, it is unlikely that the same strategy can be applied; however, other interventions may be considered, such as group formation and assigning connectors to groups or providing explicit suggestions through the design of discussion prompts on how to interact with others. The concluding chapter will explore this idea in more detail. For now, the main point to consider is that connectors do adopt supportive roles that pivot knowledge construction. Further studies can investigate whether applying roles to connectors may have an impact on a sequential process of knowledge construction in MOOCs.

These explanations point to an important question: should participants with high centrality measures be categorized as connectors if they do not support knowledge construction in an xMOOC? To answer this question, we need to return to the concept of complex systems and emergence. As mentioned in the Introduction, emergence, as defined by Goldstein (1999, p. 49),

> refers to the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems. Emergent phenomena are conceptualized as occurring on the macro level, in contrast to the micro-level components and processes out of which they arise.

Additionally, emergence in complex systems is determined by nonlinear interactions among the components based on a set of rules of the system; additionally, interactions often occur across different inter-connected levels of the system (Mitchell, 2009; Morrison, 2008). This complex systems perspective suggests that participants' interactions with others in the discussion thread and across the whole learning network enables connectors and knowledge construction to emerge. *Figure 21* illustrates the interconnected levels of analysis in an xMOOC as a complex system.

**Figure 21**
*Three interconnected levels of analysis in an xMOOC as a complex system*




*Note. Connectors and knowledge construction indicate that they are emergent phenomena as the result of interactions among various components across different levels of analysis in the system (i.e. learning network).*

Using this definition of emergence, SNA reveals that connectors emerge in a positional sense, only. In other words, participant roles emerge through interactions across the learning network, but only as "unconcerned influencers" as defined by Sedereviciute and Valentini (2011). "Unconcerned influencer" fits as a description because it describes participants who position themselves in a place within the learning network but do not go beyond that positioning. On the surface, they are positioned to be connectors, but they do not exhibit the behaviour of connectors or "brokers" of knowledge construction. Findings show that these "unconcerned influencers" emerge spontaneously in xMOOC, which should

not be surprising, given that some xMOOC participants are known to post frequently (Wise and Cui, 2018b).

The emergence of knowledge construction, however, does not occur when participants interact with "unconcerned influencers". Unlike cMOOCs, where there is an argument (Siemens, 2014; Wang et al., 2017) that self-organization and knowledge construction do occur, this study shows that xMOOCs constrain connectors by design; there are no explicit rules to encourage connectors to support knowledge construction. Of course, some scholars argue that this is also true for cMOOCs (Anderson and Dron, 2011; Kop and Hill, 2008). In short, findings from both courses indicate that there is little opportunity for connectors to support knowledge construction in xMOOCs because there is a lack of reciprocity. There are no activities that encourage participants to question, quote, complement or agree or disagree with each other. There is little incentive for collaborative dialogue which is needed for knowledge construction. Emergence of knowledge construction in xMOOCs is dependent on design (Alonso-Mencia et al., 2020), which will be discussed in more detail in the next chapter. As Wise and Cui (2017) suggest, there is "little attention […] given to discussions as an element of MOOC pedagogy and they are generally offered as an optional enhancement to the course, rather than an integrally designed element of it."

## 4.3 Summary of Chapter 4

This chapter began by reporting and discussing the findings of the social network analysis of participants' engagement in the discussion forums. The SNA findings suggest that there are identifiable participants who have high centrality scores, which may be useful in identifying whether participants who are highly connected in a MOOC learning network provide any support for knowledge construction in the discussion forums. The social network analysis of participants' engagement in the discussion forums for each iteration of the case indicate that five categories of connectors who potentially have pivotal roles in knowledge construction can be identified. The categories of connectors are: (1) high degree and closeness centrality, (2) high degree and betweenness centrality, (3) high betweenness and closeness centrality, (4) high degree centrality, and (5) high betweenness centrality. Literature suggests that the participants with high centrality scores have the potential to influence learning outcomes. Reasons given for this may be due to the type of social ties that develop as a result of being central in the network, or the formation of social ties as the result of their engagement.

The chapter then reports on the findings of the IAM content analysis of discussion threads where the identified categories of connectors post messages. The goal was to determine how connectors may support knowledge construction in the discussion forum. This chapter then reports that there does not seem to be any correlation between high centrality scores and a connector's influence on knowledge construction. Furthermore, findings suggest that connections, or the presence of connectors, are not "good" enough to enable learning to

occur and that knowledge construction as defined by Gunawardena et al. (1997) within the MOOC learning networks is limited. The presence of connectors does not automatically influence participants' understanding or development of new knowledge as a result of their interactions in the discussion forum. The chapter concludes by discussing how the research questions were addressed, suggesting that connectors' roles to support knowledge construction in MOOC discussion forums do not spontaneously emerge and that explicit instructions or roles may be needed if a sequence of knowledge construction at high KC phases were to occur.

# Chapter 5: Conclusions and Reflections

This chapter discusses the contribution of this study to the knowledge in the field of MOOC research. This is followed by a reflection on the implications this study has for practice, particularly in future design of MOOCs. The chapter ends with suggestions for further research and final thoughts on knowledge construction in MOOCs.

## 5.1 Contribution of the research

This thesis has contributed to the field of MOOC research by adding knowledge to the existing literature about MOOCs and networked learning. In particular, this research contributes to the knowledge of participants' engagement, learning outcomes and knowledge construction in xMOOCs by pointing out how a mixed methods approach to analysing learning networks can inform researchers about the role of highly connected participants in supporting knowledge construction in a learning network. There is a lack of understanding of how learning outcomes are best achieved in xMOOCs, in part because of the sheer number of participants involved and the scale of the courses. One reason for this is that there is little empirical research on how xMOOC participants engage to construction of knowledge and achieve the learning outcomes of a course. However, as this study shows, by analysing social relations in an xMOOC through SNA of discussion forums, it becomes possible to gain insight on how connectors may or may not have an impact on knowledge construction.

As mentioned, the current literature on MOOCs provides categories of participants, such as: only registered, only viewed, only explored, no shows, passive participants, or active participants (Hill, 2013, Ho et al., 2014; Ramesh et al. 2014). Yet, as pointed out by some scholars (Gašević et al. 2019; Wise and Chiu, 2011; Wise and Cui, 2018a; Haythornthwaite, 2019), these provide little insight on what role those categories have in supporting knowledge construction among MOOC participants. Considering this, social network analysis and the exploration of relational ties in a learning network has the potential to inform researcher of how knowledge construction and learning outcomes occur in xMOOCs. The following sections describe how the results of this study provide insight on (1) the roles connectors have in supporting knowledge construction in xMOOCs, (2) patterns of knowledge construction in xMOOCs, (3) relational ties and learning communities in xMOOCs, (4) how SNA can be used as a theoretical and methodological approach to analysing learning outcomes in xMOOCs, and (5) complexity as a theoretical framework.

### 5.1.1 The role of connectors in supporting KC in xMOOCs

There are a few attempts in the literature that explore connectivity and relational ties in MOOCs; however, how knowledge construction emerges through collaborative dialogue with participants who have high centrality measures needs further exploration. Current literature has yet to explain the role connectivity measures play in collaborative dialogue in xMOOCs. Gašević's et al. (2019) suggest that roles often emerge spontaneously or are negotiated spontaneously by participants, without the influence of the teacher. While other

literature suggests participants with high centrality measures with either weak or strong ties are those most likely to influence knowledge transfer and knowledge construction. Considering this, one would expect that connectors in an xMOOC learning network influence knowledge construction. However, findings from this study suggest otherwise. This is important because it shows how knowledge construction as a strand of learning is not influenced by the frequency of participants' engagement (e.g. group discussions) in MOOCs. In fact, the results call into question whether learning as knowledge construction occurs in MOOCs, and suggests that some form of intervention, whether through instructional design, by teachers, or through assigned roles, is needed for it to occur. Connectors are only one element within the complex system of MOOCs, and, for knowledge construction to emerge, these interventions need a set of rules to guide connectors on how to interact with other participants, and vice versa.

This study reveals that connectors emerge through the process of preferential attachment due to their frequent posting and high centrality measurements. In theory, connectors, who "play an important role to ensure connectivity, to share of information, and for behaviour cascading in networks" (Schreurs et al. 2019, p. 12) can exist in xMOOCs. These connectors "have more power in the network because they have access to many resources and these participants are likely to play a key role in the discussion forums" (Schreurs et al. 2019, p. 12). To understand the role of connectors in supporting knowledge construction in xMOOCs, it is necessary to analyse the process of how it emerges (if it does) through interaction. However, there is no evidence of reciprocity or transitivity between connectors and other participants. Without the reciprocity or transitivity, it is unlikely that connectors

can adopt roles that support knowledge construction, despite the "power" their position in the learning network gives them. For example, Schreurs et al. (2019) posit that reciprocity is an important factor that promotes learning, yet identifying reciprocity alone is not enough; it's equally important to analyse how participants form reciprocal ties. Findings from the SNA and IAM analysis indicate that reciprocal ties do not emerge between connectors and other participants, which is inconsistent with Schreurs et al.'s (2019, p. 20) suggestion that "reciprocity and transitivity are significantly present in both small and large learning networks in formal, non-formal and informal contexts". However, it supports the argument that "interaction must be intentionally designed into the learning network or it is unlikely to emerge both in small formal learning networks as in large and informal learning networks like MOOCs" (Schreurs et al. 2019).

One explanation for why connectors do not adopt the role of supporting knowledge construction in xMOOC is that discussion forums are designed and used differently than smaller online courses, where knowledge construction has traditionally been analysed (e.g. Wise and Chiu, 2011). Knowledge construction in smaller online courses is viewed as a social phenomenon dependent on the interactions among people within a community (Lave and Wenger, 1991; Wenger, 1998) and is a collaborative process (Garrison, 2011; Stahl, 2006). Considering this, the IAM (Gunawardena's et al., 1997) is a useful tool to analyse and measure knowledge construction in online discussion forums when roles are assigned. For example, research, such as Wise and Chiu (2011), indicate that assigning roles increases higher phases of knowledge construction through collaborative dialogue. However, roles are not assigned in xMOOCs and would be difficult to do so. There is the

argument (Gašević et al. 2019) that roles emerge spontaneously in xMOOCs, but findings from this study indicate that this is unlikely to occur.

The findings from this study have implications for understanding connectors' roles in supporting knowledge construction in xMOOCs. First, high centrality measurements in xMOOC learning network have little to no impact on how knowledge construction occurs among participants. Literature from other disciplines and social network theories (Granovetter, 1973; Kotowski and Santos, 2010; Williams 2006) posits that connectors with weak ties (i.e. high betweenness centrality measures) provide new knowledge and bridge people to "form and maintain close acquaintances with others from different groups within a larger social network" (Granovetter, 1973; Kotowski and Santos, 2010). Considering this, relations and connections among learners can influence both quality and quantity of knowledge construction and sharing (Chiu et. al, 2006; Oztok et al., 2013). Yet, findings from this study indicate that this does not happen in xMOOCs. There is no evidence that connectors engage in the variety of interactions that Wise and Cui (2018a, p. 237) suggest are needed for learning to occur in xMOOC discussion, such as: "(a) clarifying what is being asked, (b) giving explanation, examples, and comparisons, (c) raising follow-up questions that arise based on the conversation, and (d) using leading questions to help others figure out answers themselves". This is interesting because connectors, theoretically, should be engaging with other participants.

In general, this study exposes the role and behaviour of xMOOC participants who hold positions of high connectivity. As mentioned before, past research (e.g. Eynon et al. 2016)

focused on correlating participants' frequency of posts in the discussion forums with pass / fail rates. However, until now, the literature has not explored the quality of posts contributed by frequent posters in relation to knowledge construction in the wider learning network and whether they have any influence on learning outcomes. Findings from this study suggest that there may be no correlation between the frequency of posts and evidence of learning outcomes. Connectors are posting to content related discussion threads, but they are not interacting with other participants, which is necessary for collaborative dialogue to occur. Again, this appears to contradict Wise and Cui's (2018a) study, which suggests that participants' engagement in content related discussion threads develops strong ties and that conversations are likely to be in greater depth.

Based on this study's findings, a connector's purpose for contributing to the discussion forums is not to interact with other participants; instead, they are contributing to the discussion prompts, only. Considering this, one may ask why connectors are frequently posting in the discussion forum. Sedereviciute and Valentini's (2011) work on the Stakeholder Salience Model (SSM) and SNA for identifying an organization's stakeholders on social media environments provides some insight on this. They posit that four categories of stakeholders exist: unconcerned influences, concerned influences, unconcerned lurkers and concerned lurkers. What is relevant to this study is the unconcerned influencer, which is defined as having

> connections within the examined network, however, do not express an interest in particular organization. They could be considered being important potential stakeholders since they possess high symbolic power over an organization […] They

> have power, however, they need to attain urgency and legitimacy attributes to become salient (by propagating certain content online) (Sedereviciute and Valentini, 2011, p. 231).

In this sense, xMOOC connectors have the power and connectivity to be influencers in the learning network, but they do not have legitimacy or contribute influential content. Additionally,

> Power is related to the position that a specific network member has in the online community, legitimacy is related to the relevance of the content discussed and shared in the network and urgency is related to the intensity and frequency of discussions on particular issues. (Sedereviciute and Valentini, 2011, p. 233)

Of course, this should not necessarily suggest that connectors cannot play a supportive role in knowledge construction. The findings from this study have implications for understanding how researchers can identify categories of participants in a learning network who are in a position to potentially influence knowledge construction. This study provides a new approach to categorizing xMOOC participants by categorizing them in connector roles based on their connectivity measures. Houston et al. (2017, p. 297) suggest that these SNA metrics "capture the extent to which one learner is exposed to the idea or knowledge of another learner". Finding in this study, for example, captures the extent to which connectors are in a position to receive and / or spread knowledge. Considering this, researchers can explore and compare how a participant with high degree centrality to one who has high betweenness centrality, and how they support knowledge construction in an xMOOC.

This study has added to the knowledge of MOOC participant engagement in that it confirms that there are distinct participants who contribute to the discussion forums more frequent than other participants. This allows researchers to identify possible categories of participant engagement that goes beyond simply describing whether they are active or not active. It shows where they are active most and with whom. In short, connectors have high centrality due to the frequency of their posts and have social ties with other participants through affiliation. Apart from that, there is little evidence that connectors develop strong relational ties with other participants or establish weak ties between groups of learners to allow knowledge transfer to occur. In this sense, the connectors identified in this study are unconcerned influencers. What the findings also suggest is that despite being in the position of influence, connectors do not spontaneously take on the role of supporting knowledge construction. As mentioned in the Introduction and Review of Literature, there is a need for further research to help identify connectors, their role or type, beyond that of lurker, active, and passive participants. The lack of reference to 'connectors' in literature suggests there is a need for further research on how participants position themselves in an xMOOC and what type of interactions and connections participants initiate within its learning network.

The significance of this study should also discuss a few limitations in exploring connectors supportive roles in knowledge construction. First, this research focuses on relational ties based on affiliation through posting in the same discussion threads. This is assuming that participants read what others post. While that was outside the scope of this research, there

should be further studies that explore directional ties in the discussion forums. For example, mapping who responds to whom, and determining whether connectors can be identified through directional ties. This is important due to the dependence of collaborative dialogue for knowledge construction to occur. However, given the scale of MOOCs, this would be very labour intensive to accomplish.

### 5.1.2 Patterns of knowledge construction in xMOOCs

The findings from this study also have implications for understanding patterns of knowledge construction in xMOOCs. In addition to explaining the role of connectors in supporting knowledge construction, this study is also able to provide insight on the sequence of knowledge construction in the discussion forums. It has already been determined that connectors do not play a pivotal role in the sequence of knowledge construction. However, this study provides insight on how other participants contribute to knowledge construction in the discussion forums. For example, the findings describe the sequence of knowledge construction in discussion threads, showing how few participants interact with each other. In particular, frequency of posts is not an indicator of how often a participant will interact directly with other participants. This also has implications for relational ties and learning communities, which will be explained in the next sections.

The literature on IAM content analysis suggests that most messages in asynchronous discussion forums rarely achieve higher phases of knowledge construction. Findings from this study support that generalization. Participants, including connectors, rarely posted

messages above Phase 3, suggesting that the quality of knowledge construction is lacking in discussion forums. This brings into question the value of discussion forums in xMOOCs as they are used in the case studies. Scholars like Goodyear (2014) and Garrison (2013) have questioned whether critical and collaborative discourse occurs in xMOOCs because of the way they are often designed. Goodyear's (2014) point on how xMOOCs are generally designed in a way that encourages unidirectional connections from the lecturer to the students, with little opportunity for students to engage in other connections seems to be true in this study. This is despite the evidence indicating that knowledge creation in an educational context is a collaborative process (Garrison, 2011). Without collaborative dialogue, it is unlikely that participants will partake in higher phases of knowledge construction.

As mentioned, for knowledge construction to occur, participants should partake in dialogue that includes "(a) clarifying what is being asked, (b) giving explanation, examples, and comparisons, (c) raising follow-up questions that arise based on the conversation, and (d) using leading questions to help others figure out answers themselves" (Wise and Cui, 2018a). Findings from this study suggest that this rarely occurs in discussion threads in which include connectors. This study contributes to the knowledge of xMOOC participants' behaviour in discussion forums by documenting patterns (or the lack of) knowledge construction. The implication of this finding is that the sequence of posts and the content of the messages need to be considered together when measuring knowledge construction and learning outcomes in an xMOOC.

### 5.1.3 Relational ties and learning communities in xMOOCs

Prior studies on asynchronous discussion forums suggests that collaborative dialogue is necessary for knowledge construction to occur. Wise and Cui (2018, p. 238) argue:

> The ability of MOOC discussion forums to realize effective peer support and collaborative learning has not yet been conclusively established. While some studies claim MOOC forums have the potential to foster social networks and facilitate peer-connections […] others claim that MOOC forum participants are dispersed crowds rather than communities of learners, evidenced by findings that in the modularized and short-lived discussion groups, learners do not move from peripheral participation to playing important roles in supporting each other's learning.

Their findings suggest that learner-learner interaction in xMOOC discussion rarely occurs, with only occasional evidence of a community of practice developing (Wenger, 1998), suggesting the importance of relational ties in an xMOOC learning network. This study found that strong relational ties do not occur, as evidenced by how most participants did not respond directly to others' posts.

The implications of this finding provides knowledge of how it may be difficult for communities of learning to develop in xMOOC discussion forums. As a result, there is little evidence of interdependent construction of knowledge. This is in contrast to Wise and Cui (2018a) who report that a small group of learners connected to form a community. Reasons for this may be due to a lack of community of inquiry (Garrison, 2011; Garrison, 2016). Despite the presence of connectors, who are in a position to develop strong ties with other participants, no strong connections were found in this study. This may explain

situations such as a lack of coherence across discussion threads. As Garrison (2016) notes, the lack of group cohesion can only reduce the quality of the discourse. These findings indicate the need for introducing more mechanisms in xMOOCs for participants to develop strong ties.

The significance of this study should also discuss a few limitations in exploring relational ties and communities of learning. Because this study takes an agent-based model approach and investigates the role of connectors and their relational ties, there are other possible agents which studies could focus on. Furthermore, this study takes a holistic approach to network analysis. It would also be interesting to explore whether clusters of participants occur and whether these clusters have strong relational ties within them.

### 5.1.4 SNA as a theoretical and methodological approach to analysing xMOOCs

Ryberg and Larson (2008) raise the question of: "how networked learning systems would look if they were genuinely based on the metaphor of networks and intersections of weak and strong ties". Considering this, this research shifts the focus of xMOOCs and treats them as social complex systems where knowledge construction and learning outcomes emerge through participants' connectivity and the emerging outcomes of their connectivity in the discussion forums. As Wise and Cui (2018b) suggest, exploring networks of how people are connected can offer insights on learning processes in online asynchronous learning networks xMOOCs.

In particular, by adopting a SNA with a IAM content analysis, this study provides an example of how a mixed methods approach provides insight on xMOOC participants' engagement with each other and the content of the course. As Wise and Cui (2018a) argue, SNA is useful for "investigating interactions" in xMOOC environments "due to its ability to extract patterns of connections between learners across the larger volumes of posts present". They add that identifying social ties is important if researchers wish to understand how learning occurs through those interactions. This study adds to the knowledge of how SNA can be used to investigate the interactions of participants who are socially central in an xMOOC learning network. Furthermore, it provides an example of how tie definitions can be used to explore assumptions about how some xMOOC participants interact in the learning network. This study found that network formation occurs when visualizing social ties based on affiliation through contributions in discussion threads. This enables and guides researcher in exploring specific discussion threads to measure the process of knowledge construction among participants.

### 5.1.5 Complexity as a theoretical framework

As Siemens (2006) notes: "learning is a multi-faceted, integrated process where changes with any one element alters the larger network. Knowledge is subject to the nuances of complex, adaptive systems" (p. 27). Using complexity theory as a theoretical framework enables researchers to view the emergence of knowledge construction as being "diverse," "messy" and dependent on "specialized nodes" connecting to each other (Siemens, 2006, p. 27). This approach allows researchers to view xMOOCs as complex systems and identify

what elements are present to enable knowledge construction as an emergent property. In short, the reasons for knowledge construction to emerge or not emerge are complex. Complexity theory offers a framework capable of observing MOOC participants' interactions with others, while simultaneously understanding that participants' engagement may be influenced by a group of participants (as a unit) and the rules that govern their engagement, such as the intervention of a connector, a teacher or the design of a discussion prompt in the MOOC forums for example.

## 5.2. Implications for practice

These findings add new knowledge on how highly connected participants interact with other participants in an XMOOC learning network. Based on the idea that a participant's connectivity places them in a position which allows for relational ties to emerge, both designers and instructors of xMOOCs can facilitate collaborative dialogue that encourages higher levels of knowledge. For example, xMOOC designers can create activities knowing that connectors most likely exist in the learning network. Another example is, if instructors are able to identify connectors in the learning network, specific roles can be assigned to connectors to encourage more collaborative dialogue. Finally, by visualizing the social relations with sociograms of a learning network, instructors are able to identify not only the participants who are highly connected, but also the groups or clusters of students they connect to, and, potentially, any participants who are on the periphery of the learning network. Furthermore, this study shows that it's possible to link relational ties to discussion thread contributions, helping an instructor identify where meaningful dialogue is occurring for knowledge construction, or learning, to occur. The following sections

describe how xMOOC designers might (1) encourage collaborative dialogue, (2) assign roles to connectors, and (3) use sociogram (or other visualization of social ties) to facilitate discussion threads. These three approaches are interdependent and interrelated and should capitalize on connectors' position in the learning network.

### 5.2.1 Encourage collaborative dialogue in a complex system through design

As mentioned in the Introduction, emergence, as defined by Goldstein (1999, p. 49),

> refers to the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems. Emergent phenomena are conceptualized as occurring on the macro level, in contrast to the micro-level components and processes out of which they arise.

Additionally, emergence in complex systems is determined by nonlinear interactions among the components based on a set of rules of the system; additionally, interactions often occur across different inter-connected levels of the system (Mitchell, 2009; Morrison, 2008a; Morrison 2008b). This complex systems perspective suggests that participants' interactions with others in the discussion thread and across the whole learning network can be influenced by rules set out by design, rules that enable connectors and knowledge construction to emerge. *Figure 21* illustrates the interconnected levels of analysis in an xMOOC as a complex system.

This is useful because it allows for consideration of multiple interacting factors that determine the behaviour of the system as a whole, which manifests emergent properties that none of the individual agents possess on their own. Findings from this study indicate

that identified relational ties through affiliation in the discussion thread do not emerge spontaneously. For example, connectors position themselves in a central position within a learning network that has power to influence; however, there is a lack of both weak and strong ties between them and other participants. Knowing that there will most likely be connectors in these positions enables xMOOC designers to create tasks, discussion prompts, principles or guidelines for participants to encourage these relational ties to occur. Design can influence the properties of connectors (e.g. centrality measurements; KC Phases) and influence their interactions with other participants, and, as a result, influence emergent behaviour in the learning network.

Considering this, xMOOC designers can encourage the emergence of connectors and knowledge construction by:

1. defining and making explicit guidelines and principles for how to participate in the discussion forum. There may be various stages in how this is done. For example, designers might provide guidelines and principles at the beginning of an xMOOC that encourage participants to introduce themselves and express their expectations of the course and other participants. Designers may then guide participants to encourage participants to post more in content-related discussion threads.
2. providing explicit instructions and expectations for discussion prompts, encouraging participants to engage with others and reflect on their understanding of the content and others' messages. Participants need to be encouraged to engage in discourse and not rely on answering discussion prompts only. Follow-up discussion prompts can ask participants to return to a previous thread and reflect

on the dialogue in comparison to what they have recently learned from the course content.

3. allowing participants to establish groups, as well as the option to have dialogue across different groups. This might be done by introducing group discussion threads, where participants are randomly assigned and are assigned a content-related task to discuss. A future discussion prompt may ask participants to read through another group's discussion and comment on the messages.
4. by implementing Gunawardena et al.'s (1997) IAM to discussion tasks and activities throughout an xMOOC. For example, a discussion prompt may explicitly ask participants to identify and state areas of disagreement throughout the discussion thread. A follow-up discussion prompt then may ask participants to negotiate meaning based on the previous dialogue.
5. having explicit guidelines and principles, xMOOC designers might include low-stakes peer-assessed tasks where participants evaluate each other contributions to a discussion. Grades could also be attributed to participation in discussion forums.
6. establishing inquiry dynamics, xMOOC designers should consider how discussion forum tasks provide participants with a path towards a resolution of some sort. For example, a processed problem-based approach to a series of discussion threads with the final goal of applying knowledge to an assessed task.
7. mapping intended learning outcomes of an xMOOC to all assessments and making it explicit to participants. Constant reminders to participants of how discussion forum tasks are designed to build knowledge on how to complete an assessed task reinforcing the intended processes and outcomes.

### 5.2.2 Assigning roles to connectors in an xMOOC

As mentioned, encouraging collaborative dialogue through design is interdependent on assigning roles to connectors within the learning network. As Wise and Chiu (2011) suggest, outcomes of knowledge construction can be enhanced when learners are assigned roles. For example, roles might include devil's advocates or synthesizers. Findings from this study suggest that roles do not emerge spontaneously in the discussion forums, despite connectivity and frequency of posting. Having the option to identify connectors and assigning them randomized roles could establish community and cohesion with the learning network. Additionally, it may also establish inquiry dynamics. Of course, xMOOC platforms to date do not appear to have features that allow instructors to assign roles to specific participants; one reason, perhaps, because of the scalability of such a task makes it difficult. However, this is an area worth exploring since it is possible to identify connectors, and research supports the notion that assigning roles can assist with knowledge construction.

### 5.2.3 Using sociograms to identify social ties and facilitate discussion threads

Finally, as discussed earlier in the results section, sociograms are beneficial for instructors as they visualize social relations within a learning network. This often includes visualizing multiple levels of analysis: the individual participants, clusters of individuals and the whole network. There is growing literature that suggests how a sociogram of an entire learning network can assist instructors and facilitators with monitoring and detecting participants'

activity in discussion forums (Buraphadeja, 2010; Ergun and Usluel, 2016; Reffay and Chanier, 2002; Shen at al., 2008).

## 5.3 Suggestions for further research

The focus of this study was to explore and analyse a connectors' role in supporting knowledge construction. However, further studies are needed to explain patterns of knowledge construction in general. For example, is there evidence that reciprocal posts occur in xMOOCs? If so, how often? If connectors are not contributing reciprocal posts, who is? And do they have an impact on knowledge construction in the discussion forum. If participants are mostly posting individual messages and ignoring others, as what Kanuka and Anderson (2007) suggest happens due to the anonymity and asynchronous nature of discussion forums, then the question of "why" arises. For example, do participants ignore others' posts for the reasons given by Kanuka and Anderson (2007), or does it have to do with how the xMOOC is designed (Goodyear, 2014).

The SNA and IAM content analysis in this study focuses on the concept of connectors and the role they might play in supporting knowledge construction. Findings suggest that further research is needed by expanding beyond a focus on connectors' roles in supporting knowledge construction. For example, how might SNA inform researchers on how knowledge transfer occurs among participants who are not connectors. So far, it's not clear whether other participants, for example those with less frequent discussion forum participation, provide pivotal messages that enable the process of knowledge construction to achieve higher phases in the IAM. It would be very interesting, for example, to explore

small clusters of participants in the learning network to explore how or whether processes of knowledge construction occur.

Additionally, it would be interesting to explore further how SNA can assist researchers with gaining insight on how xMOOC participants interact with each other. As mentioned, this study assumes that relational ties are based on affiliation through posting in the same discussion threads. However, further research on directional ties, for example, might provide a different perceptive on how knowledge is constructed in the discussion forums. For example, it would be interesting to see if participants who directly respond to others and are reciprocal in dialogue in the forums have different outcomes in knowledge construction as opposed to those who never engage others.

## 5.4 Final Reflections

As some suggest (Garrison, 2016; Carvalho and Goodyear, 2014), MOOCs are having an impact on higher education, but their design is still heavily based on basic knowledge of distance learning and self-paced learning. While the interest in online learning is welcoming, xMOOC design seems to be ignoring the more recent developments in online learning or networked learning research. Regardless of this, the number of xMOOCs produced by universities around the world is growing. A question of value arises here. Are xMOOCs adding value to higher education experiences and learning outcomes? Research from this study suggests that learning outcomes in relation to knowledge construction may be limited. However, this does not mean that xMOOC research cannot add knowledge to the

broader category of online learning. The fact that MOOCs significantly increase the scalability of the number of learners is all the more reason for researchers to explore them. Until more recently, most research on collaborative dialogue or computer supportive collaborative learning has had to focus on smaller communities or networks of learners. Research on network learning in MOOCs may provide more insights on how knowledge construction occurs in large defined learning networks.

This study reveals that there are identifiable xMOOC participants who frequently participant in the discussion forums and position themselves in highly centralized positions where they can potentially interact with most other participants. However, their position as connectors in the learning network seems to have little impact on others, mostly because they are not directly engaging others. In fact, there appears to be few occurrences where a sequence of messages in the discussion forums leads to pivotal moments of higher phases of knowledge construction.

However, knowing that there is the potential for collaborative dialogue among such a massive scale of participants to occur is reason enough to explore how educators might capitalize on better xMOOC design. The literature has shown how relational ties such as strong and weak ties can enable communities of practice or communities of inquiry to be productive. Additionally, there is empirical evidence that assigning roles to learners also influences the learning outcomes in a learning network. More research is needed to explore different learning outcomes that emerge in xMOOCs as a result of participants' interactions

so that engagement prompts can be better designed. Despite the criticism of xMOOCs, they do have potential to provide a productive learning network.

# References


Alario-Hoyos, C., Muoz-Merino, P. J., Perez-Sanagustin, M., Delgado Kloos, C., and Parada, G. (2016). Who are the top contributors in a MOOC? Relating participants' performance and contributions. *Journal of Computer Assisted Learning*, 232–243. https://doi.org/10.1111/jcal.12127

Alario-Hoyos, C., Pérez-Sanagustín, M., Elgado-Kloos, C., Parada, G., and Munoz-Organero, M. (2016). Delving into participants' profiles and use of social tools in MOOCs. *IEEE Transactions on Learning Technologies*, *3*.

Alonso-Mencía, M. E., Alario-Hoyos, C., Maldonado-Mahauad, J., Estévez-Ayres, I., Pérez-Sanagustín, M., and Delgado Kloos, C. (2020). Self-regulated learning in MOOCs: lessons learned from a literature review. *Educational Review*, *72*(3), 319–345. https://doi.org/10.1080/00131911.2019.1566208

Anderson, T., and Dron, J. (2014). *Teaching Crowds: Learning and Social Media*.

Anderson, T., and Gunawardena, C. (1997). Analysis of a Global Online Debate and the Development of an Interaction Analysis Model for Examining Social Construction of Knowledge in Computer Conferencing. *Technical Writing and Communication*, *17*(4). Retrieved from http://auspace.athabascau.ca/bitstream/2149/772/1/ANALYSIS_OF_A_GLOBAL.pdf

Bates, T. (2012a). More reflections on MOOCs and MITx. Retrieved from http://www.tonybates.ca/2012/03/03/more-reflections-on-moocs-and-mitx/

Bates, T. (2012b). What's right and what's wrong about Coursera-style MOOCs. Retrieved June 3, 2013, from http://www.tonybates.ca/2012/08/05/whats-right-and-whats-wrong-about-coursera-style-moocs/

Bates, T. (2013). How to Make MOOCs Really Effective. In *LINC 2013 Conference*.

Bates, T. (2014). MOOCs: getting to know you better. *Distance Education*, *35*(2), 145–148. https://doi.org/10.1080/01587919.2014.926803

Borgatti, S. P., Everett, M. G., and Johnson, J. C. (2013). *Analyzing Social Networks*. London: Sage.

Breslow, L., Pritchard, D., DoBoer, J., Stump, G., Ho, A., and Seaton, D. (2013). Studying Learning in the Worldwide Classroom Research into edX's First MOOC. *Research and Practice in Assessment*, *8*, 13–25. Retrieved from http://www.rpajournal.com/dev/wp-content/uploads/2013/05/SF2.pdf

Brinton, C. G., Chiang, M., Jain, S., Lam, H., Liu, Z., and Wong, F. M. F. (2013). Learning about social learning in MOOCs: From statistical analysis to generative model, *7*(4), 2013–2014. https://doi.org/10.1145/2556325.2567860

Brinton, C. G., Member, S., Buccapatnam, S., Chiang, M., and Poor, H. V. (2016). Mining MOOC Clickstreams : Video-Watching Behavior vs . In-Video Quiz Performance, *64*(14), 3677–3692. https://doi.org/10.1109/TSP.2016.2546228

Buraphadeja, V. (2010). *An Assessment of Knowledge Construction in an Online Discussion Forum: The Rrelationship Between Content Analysis and Social Network Analysis*. University of Florida.

Campbell, J., and Gibbs, A. (2014). A comparison of learner intent and behaviour in live and archived MOOCs. *The International Review of …*, *15*(5). Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/1854

Canal, L., Ghislandi, P., and Micciolo, R. (2015). Pattern of accesses over time in an online asynchronous forum and academic achievements. *British Journal of Educational*

*Technology*, *46*(3), 619–628. https://doi.org/10.1111/bjet.12158

Carolan, B. (2014). *Social Network Analysis and Education: Theory, Methods and Applications*. Lonmdon: Sage.

Chen, B., deNoyelles, A., Patton, K., and Zydney, J. (2017). Creating a community of inquiry in large-enrollment online courses: An exploratory study on the effect of protocols within online discussions. *Online Learning Journal*, *21*(1), 165–188. https://doi.org/10.24059/olj.v21i1.816

Cherryholmes, C. H. (1992). Notes on Pragmatism and Scientific Realism. *Educational Researcher*, *21*(6), 13. https://doi.org/10.2307/1176502

Chiu, C. M., Hsu, M. H., and Wang, E. (2006). Understanding Knowledge Sharing in Virtual Communities: An Integration of Social Capital and Social Cognitive Theories. *Decision Support Systems*, *42*(3).

Clow, D. (2013). MOOCs and the Funnel of Participation. In *Third Conference on Learning Analytics and Knowledge*. Belgium. Retrieved from http://oro.open.ac.uk/36657/

Cobos, R., and Pifarre, M. (2008). Collaborative knowledge construction in the web supported by the KnowCat system. *Computers and Education*, *50*(3).

Coetzee, D., Fox, A., Hearst, M. A., and Hartmann, B. (2014). Should your MOOC forum use a reputation system? In *Proceedings of the 17th ACM conference on Computer supported cooperative work and social computing - CSCW '14* (pp. 1176–1187). New York, New York, USA: ACM Press. https://doi.org/10.1145/2531602.2531657

Coffrin, C., Corrin, L., de Barba, P., and Kennedy, G. (2014). Visualizing patterns of student engagement and performance in MOOCs. *Proceedins of the Fourth International Conference on Learning Analytics And Knowledge - LAK '14*, 83–92.

https://doi.org/10.1145/2567574.2567586

Cohen, L., Manion, L. and Morrison, K. (2007). The Nature of Enquiry: Setting the Field. In *Research Methods in Education* (6th ed., pp. 28–30). Routledge. Retrieved from http://books.google.com/books?hl=enandlr=andid=qOs36d2SXrACandoi=fndandpg=PA57anddq=Validity+and+Reliabilityandots=aBcS_4LU2-andsig=p0K1tpIfL00bzaMcrvb-PD0dsUE

Cresswell, C., and Clark, V. (2018). *Designing and Conducting Mixed Methods Research*. (3rd edition) Sage.

Creswell, J. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th edition). Sage.

Dawson, S. (2008). International Forum of Educational Technology and Society: A study of the relationship between student social networks and sense of community. *Journal of Educational Technology and Society*, *11*(3), 224–238.

De Laat, M., Lally, V., Lipponen, L., and Simons, R. J. (2007). Investigating patterns of interaction in networked learning and computer-supported collaborative learning: A role for Social Network Analysis. *International Journal of Computer-Supported Collaborative Learning*, *2*(1), 87–103. https://doi.org/10.1007/s11412-007-9006-4

Deng, R., Benckendorff, P., and Gannaway, D. (2019). Progress and new directions for teaching and learning in MOOCs. *Computers and Education*, *129*(February), 48–60. https://doi.org/10.1016/j.compedu.2018.10.019

DeSantis, N. (2012). Online Enrollments Grow Again, Though Many Colleges Are Undecided on MOOCs. Retrieved June 3, 2013, from http://chronicle.com/blogs/ticker/online-course-enrollments-grow-again-though-many-colleges-are-undecided-on-

moocs/53787

de Waard, I., Abajian, S., Gallagher, M. S., Hogue, R., Keskin, N., Koutropoulos, A., & Rodriguez, O. C. (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. https://doi.org/10.19173/irrodl.v12i7.1046

Dowell, N. M. M., Skrypnyk, S., Joksimović, S., Graesser, A., Dawson, S., Gašević, D., … Kovanović, V. (2015). Modeling Learners ' Social Centrality and Performance through Language and Discourse. In *Educational Data Mining - EDM'15*. Retrieved from https://www.researchgate.net/publication/274383696_Modeling_Learners'_Social_Centrality_and_Performance_through_Language_and_Discourse

Edwards, G. (2010). ESRC National Centre for Research Methods Review paper Mixed-Method Approaches to Social Network Analysis.

Ergun, E. and Usluel, Y. K. (2016). An Analysis of Density and Degree-Centrality According to the Social Networking Structure Formed in an Online Learning Environment. Educational Technology and Society, 19 (4), 34-46.

Eynon, R., Hjorth, I., Yasseri, T., and Gillani, N. (2016). Understanding Communication Patterns in MOOCs: Combining Data Mining and qualitative methods. Retrieved from http://arxiv.org/abs/1607.07495

Fini, A. (2009). The technological dimension of a massive open online course: The case of the CCK08 course tools. *The International Review of Research in Open and …*, *10*(5). Retrieved from http://www.irrodl.org/index.php/irrodl/article/viewArticle/643

Fu, S., Zhao, J., Cui, W., and Qu, H. (2017). Visual Analysis of MOOC Forums with iForum.

*IEEE Transactions on Visualization and Computer Graphics*, *23*(1), 201–210. https://doi.org/10.1109/TVCG.2016.2598444

Garrison, D. R., Anderson, T., and Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *International Journal of Phytoremediation*, *21*(1), 7–23. https://doi.org/10.1080/08923640109527071

Garrison, R. (2011). *E-Learning in the 21st century: A framework for research and practice* (2nd ed.). London: Routledge/Taylor and Francis.

Garrison, R. (2015). *Thinking Collaboratively: Learning in a Community of Inquiry*. London: Routledge/Taylor and Francis.

Gašević, D., Joksimović, S., Eagan, B. R., and Shaffer, D. W. (2019). SENS: Network analytics to combine social and cognitive perspectives of collaborative learning. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.07.003

Gee, J. P. (2005). Semiotic Social Spaces and Affinity Spaces From The Age of Mythology to Today's Schools. In *Beyond Communities of Practice: Language Power and Social Context* (pp. 214–232). Cambridge University Press.

Gee, J. P., and Hayes, E. R. (2011). *Language and Learning in the Digital Age*. Routledge.

Gillani, N., and Eynon, R. (2014a). Communication patterns in massively open online courses. *The Internet and Higher Education*, *23*, 18–26. https://doi.org/10.1016/j.iheduc.2014.05.004

Gillani, N., and Eynon, R. (2014b). Communication patterns in massively open online courses. *The Internet and Higher Education*, *23*, 18–26. https://doi.org/10.1016/j.iheduc.2014.05.004

Gladwell, M. (2000). *The Tipping Point: How Little Things Can Make a Big Difference*. Little

Brown.

Gomez-Zermeno, M., and Aleman, L. (2016). Research Analysis on Mooc Course Dropout and R. *Turkish Online Journal of Distance Education*, *17*(4), 3–14.

Goodyear, P. (2014). Productive Learning Networks: The Evolution of Research and Practice. In L. Carvalho and P. Goodyear (Eds.), *The Architechture of Productive Learning Networks*. Routledge.

Goodyear, P., Banks, S., Hodgson, V., and McConnell, D. (2004). Research on networked learning: An overview. In P. Goodyear, S. Banks, V. Hodgson, and D. McConnell (Eds.), *Advances in Research on Networked Learning*. Springer.

Goodyear, P., Carvalho, L., and Dohn, N. B. (2014). Design for networked learning: framing relations between participants' activities and the physical setting. *Ninth International Conference on Networked Learning 2014*, 137–144. Retrieved from http://www.networkedlearningconference.org.uk/abstracts/pdf/goodyear.pdf

Granovetter, M. S. (1973). The Strength of Weak Ties. *American Journal of Sociology*, *78*(6), 1360. https://doi.org/10.1086/225469

Gunawardena, C. N., Flor, N. V, Gómez, D., and Sánchez, D. (2016). Analysis Interaction Social Construction of Knowledge Conferencing, *17*(3), 35–60.

Gunawardena, C. N., Flor, N. V., Gómez, D., and Sánchez, D. (2016). Analyzing Social Construction of Knowledge Online by Employing Interaction Analysis, Learning Analytics, and Social Network Analysis. *The Quarterly Review of Distance Education*, *17*(3), 35–60.

Gunawardena, C. N., Lowe, C., and Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social

construction of knowledge in computer conferencing. *Journal of Educational Computing Research*, *17*(4), 397–431. Retrieved from http://baywood.metapress.com/index/7MQVX9UJC7Q3NRAG.pdf

Guo, S., and Wu, W. (2015). Modeling Student Learning Outcomes in MOOCs. *Admire.Nlsde.Buaa.Edu.Cn*. Retrieved from http://admire.nlsde.buaa.edu.cn/paper/2015-3.pdf

Hansen, M. T. (1999). The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge across Organization Subunits. *Administrative Science Quarterly*, *44*(1), 82–111.

Haythornthwaite, C. (2019). Learning, connectivity and networks. *Information and Learning Science*, *120*(1–2), 19–38. https://doi.org/10.1108/ILS-06-2018-0052

Haythornthwaite, C., and de Laat, M. (2012). Social Network Informed Design for Learning with Educational Technology. In A. Olofsson, and J. Lindberg (Eds.), Informed Design of Educational Technologies in Higher Education: Enhanced Learning and Teaching (pp. 352-374). IGI Global. http://doi:10.4018/978-1-61350-080-4.ch018

Haythornthwaite, C., de Laat, M., and Schreurs, B. (2016). A Social Network Analytic Perspective on E-Learning. In C. Haythornthwaite, R. Andrews, J. Fransman, and E. Meyers (Eds.), *The SAGE Handbook of E-learning Research*. Sage Publications Ltd.

Heo, H., Lim, K. Y., and Kim, Y. (2010). Exploratory study on the patterns of online interaction and knowledge co-construction in project-based learning. *Computers and Education*, *55*(3), 1383–1392. https://doi.org/10.1016/j.compedu.2010.06.012

Hill, P. (2013). Emerging Student Patterns in MOOCs: A (Revised) Graphical View. Retrieved April 13, 2015, from http://mfeldstein.com/emerging-student-patterns-in-moocs-a-

revised-graphical-view/

Ho, A. D., Reich, J., Nesterko, S. O., Seaton, D. T., Mullaney, T., Waldo, J., and Chuang, I. (2014). *HarvardX and MITx: The First Year of Open Online Courses*. Retrieved from http://ssrn.com/abstract=2381263

Hodgson, V., McConnell, D., and Dirckinck-Holmfeld, L. (2012). Exploring the Theory, Pedagogy and Practice of Networked Learning. In L. Dirckinck-Holmfeld, V. Hodgson, and D. McConnell (Eds.) (pp. 291–305). New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-0496-5_17

Hou, H., Chang, K. E., and Sung, Y. (2008). Analysis of problem-solving-based online asynchronous discussion pattern. *Educational Technology andSociety*, *11*(1).

Hullinger, H., and Robinson, C. C. (2008). New Benchmarks in Higher Education: Student Engagement in Online Learning. *Journal of Education for Business*. Retrieved from http://anitacrawley.net/Resources/Articles/New Benchmarks in Higher Education.pdf

Jiang, S., Fitzhugh, S., and Warschauer, M. (2014). Social Positioning and Performance in MOOCs. In *7th International Conference on Educational Data Mining* (pp. 55–59).

Jones, C., and De Laat, M. F. (2016). Networked learning. In *The SAGE Handbook of E-learning Research* (2nd ed., pp. 43–62). London: Sage Publications Ltd.

Jones, C., and Steeples, C. (2002). *Networked Learning: Perspectives and Issues. Computer Supported Cooperative Work.* London: Springer.

Jones, C. R., Ferreday, D., and Hodgson, V. (2008). Networked learning a relational approach: Weak and strong ties. *Journal of Computer Assisted Learning*, *24*, 90–102. https://doi.org/10.1111/j.1365-2729.2007.00271.x

Kanuka, H., and Anderson, T. (2007, August 11). Online Social Interchange, Discord, and Knowledge Construction. *International Journal of E-Learning and Distance Education*. Retrieved from http://www.ijede.ca/index.php/jde/article/view/137/412

Kaplan, A. M., and Haenlein, M. (2016). Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster. *Business Horizons*, *59*(4), 441–450. https://doi.org/10.1016/j.bushor.2016.03.008

Kellogg, S. (2014). *Patterns of Peer Interaction and Mechanisms Governing Social Network Structure in Three Massively Open Online Courses for Educators*. North Carolina State University. Retrieved from https://repod.lib.ncsu.edu/bitstream/handle/1840.16/9549/etd.pdf?sequence=2andisAllowed=y

Kizilcec, R. F., Pérez-Sanagustín, M., and Maldonado, J. J. (2017). Self-regulated learning strategies predict learner behavior and goal attainment in Massive Open Online Courses. *Computers and Education*, *104*, 18–33. https://doi.org/10.1016/j.compedu.2016.10.001

Kizilcec, R. F., and Piech, C. (2013). Deconstructing Disengagement: Analyzing Learner Subpopulations in Massive Open Online Courses Categories and Subject Descriptors. In *Proceedings of the Third International Conference on Learning Analytics and Knowledge* (pp. 170–179).

Kop, R. (2012). The unexpected connection: Serendipity and human mediation in networked learning. *Educational Technology and Society*, *15*(2), 2–11.

Kop, R., and Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past? *International Review of Research in Open and Distance Learning*, *9*(3).

https://doi.org/10.19173/irrodl.v9i3.523

Kotowski, M. R., and dos Santos, G. M. (2010). The role of the connector in bridging borders through virtual communities. *Journal of Borderlands Studies*, *25*(3–4), 150–158. https://doi.org/10.1080/08865655.2010.9695777

Koutropoulos, A., and Gallagher, M. (2012). Emotive Vocabulary in MOOCs: Context and Participant Retention. *European Journal of …*, 1–22. Retrieved from http://www.eurodl.org/index.php?pandarticle=507

Kovanovic, V., Joksimovic, S., Gašević, D., Siemens, G., and Hatala, M. (2015). What public media reveals about MOOCs: A systematic analysis of news reports. *British Journal of Educational Technology*, *46*(3), 510–527. https://doi.org/10.1111/bjet.12277

Kumpulainen, K., and Saadatmand, M. (2014). Participants' Perceptions of Learning and Networking in Connectivist MOOCs. *MERLOT Journal of Online Learning and Teaching*, *10*(1), 16–30.

Laghos, A., and Zaphiris, P. (2006). Sociology of student-centred e-Learning communities: A network analysis. In *Proceedings of the IADIS international conference, e-Society*.

Lambert, S. R. (2020). Do MOOCs contribute to student equity and social inclusion? A systematic review 2014–18. *Computers and Education*, *145*(November 2018), 103693. https://doi.org/10.1016/j.compedu.2019.103693

Lave, J., and Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. (R. Pea and J. S. Brown, Eds.), *Learning in doing* (Vol. 95). Cambridge University Press. https://doi.org/10.2307/2804509

Lee, D., Watson, S. L., and Watson, W. R. (2018). Systematic literature review on self-regulated learning in massive open online courses PIES: Technology for the Learner-

Centered Paradigm of Education View project Systematic literature review on self-regulated learning in massive open online courses. *Article in Australasian Journal of Educational Technology*, *35*(1), 35. https://doi.org/10.14742/ajet.3749

Levin, D. Z., and Cross, R. (2004, November). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management Science*. https://doi.org/10.1287/mnsc.1030.0136

Lewin, T. (2013, February 20). Universities Abroad Join MOOC Course Projects. *New York Times*. Retrieved from http://www.nytimes.com/2013/02/21/education/universities-abroad-join-mooc-course-projects.html?_r=0

Liyanagunawardena, T. R., Adams, A. A., and Williams, S. A. (2013). MOOCs: A systematic study of the published literature 2008-2012. *International Review of Research in Open and Distance Learning*, *14*(3), 202–227. https://doi.org/10.19173/irrodl.v14i3.1455

Lucas, M., Gunawardena, C., and Moreira, A. (2014). Assessing social construction of knowledge online: A critique of the interaction analysis model. *Computers in Human Behavior*, *30*, 574–582. https://doi.org/10.1016/j.chb.2013.07.050

Maina, M., Sangrà, A., and Guardia, L. (2013). *MOOC Design Principles. A Pedagogical Approach from the Learner's Perspective | Open Education Europa*. Retrieved from http://www.openeducationeuropa.eu/en/article/MOOC-Design-Principles.-A-Pedagogical-Approach-from-the-Learner's-Perspective

McAuley, A., Stewart, B., Siemens, G., and Cormier, D. (2010). *The MOOC model for digital practice*. Retrieved from http://davecormier.com/edblog/wp-content/uploads/MOOC_Final.pdf

McConnell, D., Dirckinck-Holmfeld, L., and Hodgson, V. (2012). Networked Learning: A Brief History and New Trends. In *Exploring the Theory, Pedagogy and Practice of Networked Learning*. Springer. Retrieved from http://link.springer.com/content/pdf/10.1007/978-1-4614-0496-5.pdf

Meyer, K. (2004). Evaluating online discussions: Four different frames of analysis. *Journal of Asynchronous Learning Networks*, *8*(2), 101–114.

Milligan, C, Littlejohn, A., and Margaryan, A. (2013). Patterns of engagement in connectivist MOOCs. *MERLOT Journal of Online Learning and Teaching*, *9*(2). Retrieved from http://jolt.merlot.org/vol9no2/abstracts.htm

Milligan, C., Littlejohn, A., and Margaryan, A. (2013). Learner Participation and Engagement in Open Online Courses: Insights from the Peer 2 Peer University. *MERLOT Journal of Online Learning and Teaching*, *9*(2), 149–159.

Mitchell, M. (2009). *Complexity: A Guided Tour*. Oxford University Press.

Montes-Rodríguez, R., Martínez-Rodríguez, J. B., and Ocaña-Fernández, A. (2019). Case study as a research method for analyzing MOOCs: Presence and characteristics of those case studies in the main scientific databases. *International Review of Research in Open and Distance Learning*, *20*(3), 59–79. https://doi.org/10.19173/irrodl.v20i4.4299

Morrison, K. (2002). *School Leadership and Complexity Theory*. Routledge.

Morrison, K. (2008). Educational philosophy and the challenge of complexity theory. *Educational Philosophy and Theory*, *40*(1), 19–34. https://doi.org/10.1111/j.1469-5812.2007.00394.x

Murray, D. J.-A. (2014). Participants' perceptions of a MOOC. *Insights: The UKSG Journal*,

*27*(2), 154–159. https://doi.org/10.1629/2048-7754.154

Najarro, I. (2013, April 22). Coursera hosts Asia's first MOOC. *The Standford Daily*. Retrieved from http://www.stanforddaily.com/2013/04/22/coursera-hosts-asias-first-mooc/

Nakano, N., Padua, M. C., and Jorente, M. J. V. (2015). MOOC as a Complex System. In B. P., C. P., and P. P. (Eds.), *First Complex Systems Digital Campus World E-Conference 2015* (pp. 125–131). Springer.

Nichani, M., and Hung, D. (2002). Can a community of practice exist online? *Educational Technology*, *42*(4), 49–54.

Onrubia, J., and Engel, A. (2009). Strategies for collaborative writing and phases of knowledge construction in CSCL environments. Computers & Education. 53(4), 1256-1265. https://doi.org/10.1016/j.compedu.2009.06.008

Oshima, J., Ritsuko, O., and Matsuzawa, Y. (2012). Knowledge Building Discourse Explorer: a social network analysis application for knowledge building discourse. *Educational Technology Research and Development*, *60*(5), 903–921. https://doi.org/10.1007/s11423-012-9265-2

Oztok, M., Zingaro, D., and Makos, A. (2013). What social capital can tell us about social presence. *British Journal of Educational Technology*, *44*(6), 2001–2004. https://doi.org/10.1111/bjet.12079

Palacios Hidalgo, F. J., Huertas Abril, C. A., and Gómez Parra, M.ª. E. (2020). MOOCs: Origins, Concept and Didactic Applications: A Systematic Review of the Literature (2012–2019). *Technology, Knowledge and Learning*, (0123456789). https://doi.org/10.1007/s10758-019-09433-6

Pappano, L. (2012, November 2). The Year of the MOOC. *The New York Times*. Retrieved from http://www.nytimes.com/2012/11/04/education/edlife/massive-open-online-courses-are-multiplying-at-a-rapid-pace.html?_r=0

Quan, C., and Ren, F. (2010). Construction of a blog emotion corpus for Chinese. *Chinese. Computer Speech and Language*, *24*(4).

Rabbany, R., Elatia, S., Takaffoli, M., and Zaïane, O. R. (2014). Collaborative learning of students in online discussion forums: A social network analysis perspective. *Studies in Computational Intelligence*. https://doi.org/10.1007/978-3-319-02738-8_16

Ramesh, A., Goldwasser, D., Huang, B., Daume, H., and Getoor, L. (2014). Uncovering hidden engagement patterns for predicting learner performance in MOOCs. In *Proceedings of the first ACM conference on Learning @ scale conference - L@S '14* (pp. 157–158). ACM Press. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84899704304andpartnerID=tZOtx3y1

Reffay, C. and Chanier, T. (2003). Social network analysis used for modelling collaboration in Distance Learning groups. Intelligent Tutoring System, Biarritz and San Sebastian, France. (pp.31-40). Retrieved from https://edutice.archives-ouvertes.fr/edutice-00000056/file/reffayIts.pdf

Ridder, H. G. (2017). The theory contribution of case study research designs. Business Research. doi:10.1007/s40685-017-0045-z

Rodriguez, O. (2013). The concept of openness behind c and x-MOOCs ( Massive Open Online Courses ), *5*(1), 67–73.

Ryberg, T., and Larsen, M. C. (2008). Networked identities: Understanding relationships between strong and weak ties in networked environments. *Journal of Computer*

*Assisted Learning*, *24*, 103–115. https://doi.org/10.1111/j.1365-2729.2007.00272.x

Ryberg, T., Buus, L., and Georgsen, M. (2012). Exploring the Theory, Pedagogy and Practice of Networked Learning. *Exploring the Theory, Pedagogy and Practice of Networked Learning*, (January). https://doi.org/10.1007/978-1-4614-0496-5

Sanchez-Gordon, S., and Luján-Mora, S. (2018). Research challenges in accessible MOOCs: a systematic literature review 2008–2016. *Universal Access in the Information Society*, *17*(4), 775–789. https://doi.org/10.1007/s10209-017-0531-2

Scardamalia, M., and Bereiter, C. (1996). Engaging Students in a Knowledge Society. *Educational Leadership*, *54*(3), 6–10.

Schreurs, B., Cornelissen, F., and De Laat, M. (2019). How do online learning networks emerge? A review study of self-organizing network effects in the field of networked learning. *Education Sciences*, *9*(4). https://doi.org/10.3390/educsci9040289

Schrire, S. (2006). Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis. *Computers and Education*, *46*(1).

Sedereviciute, K., and Valentini, C. (2011). Towards a More Holistic Stakeholder Analysis Approach. Mapping Known and Undiscovered Stakeholders from Social Media. *International Journal of Strategic Communication*, *5*(4), 221. https://doi.org/10.1080/1553118X.2011.592170

Sharma, Y. (2013a). Asia's first MOOC draws students from around world - University World News. Retrieved March 8, 2015, from http://www.universityworldnews.com/article.php?story=20130417153545600

Sharma, Y. (2013b, April 22). Hong Kong MOOC Draws Students from Around the World. *The Chronicle of Higher Education*. Retrieved from http://chronicle.com/article/Hong-

Kong-MOOC-Draws-Students/138723/

Shen, D., Nuankhieo, P. Huang, X., Amelung, C. and Laffey, J. (2008). Using social network analysis to understand sense of community in an online learning environment. Journal of Educational Computing Research. 39 (1). 17-36.

Shi, C., Fu, S., Chen, Q., and Qu, H. (2014). VisMOOC: Visualizing Video Clickstream Data from Massive Open Online Courses. In *2014 IEEE Conference on Visual Analytics Science and Technology (VAST)* (pp. 277–278).

Siemens, G. (2006). *Knowing Knowledge*. Creative Commons.

Siemens, G. (2014). Where Is Research on Massive Open Online Courses Headed ? *International Review of Research in Open and Distance …*, *15*(5).

Sinha, T. (2014a). Supporting MOOC Instruction with Social Network Analysis. *ArXiv Preprint ArXiv:1401.5175*. Retrieved from http://arxiv.org/abs/1401.5175

Sinha, T. (2014b). Together we stand, Together we fall, Together we win: Dynamic team formation in massive open online courses. *The Fifth International Conference on the Applications of Digital Information and Web Technologies (ICADIWT 2014)*, 107–112. https://doi.org/10.1109/ICADIWT.2014.6814694

Smith, E. R., and Conrey, F. R. (2007). Agent-based modeling: A new approach for theory building in social psychology. *Personality and Social Psychology Review*, *11*(1), 87–104. https://doi.org/10.1177/1088868306294789

Stahl, G. (2004). Building collaborative knowing: Elements of a social theory of CSCL. In *What we know about CSCL: And implementing it in higher education* (pp. 53–86). Retrieved from citeulike-article-id:6583964

Stahl, G. (2005). Group cognition in computer-assistedcollaborative learning. *Journal of*

*Computer Assisted Learning*, *21*, 79–90.

Stahl, G. (2006). A Model of Collaborative Knowledge Building. In *Group Cognition : Computer Support for Building Collaborative Knowledge*. MIT Press. Retrieved from http://ebookcentral.proquest.com

Stracke, C. M., Downes, S., Conole, G., Burgos, D., and Nascimbeni, F. (2019). Are MOOCs Open Educational Resources? A literature review on history, definitions and typologies of OER and MOOCs. *Open Praxis*, *11*(4), 331. https://doi.org/10.5944/openpraxis.11.4.1010

Strijbos, J. W., Martens, R. L., Prins, F. J., & Jochems, W. M. (2006). Content analysis: What are they talking about? Computers & education, 46(1), 29-48.

Sunar, A. S., White, S., Abdullah, N. A., and Davis, H. C. (2017). How learners' interactions sustain engagement: A MOOC case study. *IEEE Transactions on Learning Technologies*, *10*(4). https://doi.org/10.1109/TLT.2016.2633268

Tam, J. (2014). HKUST cooks up MOOC - an online class open to all. *South China Morning Post*. Retrieved from http://www.scmp.com/news/hong-kong/article/1500166/hkust-cooks-mooc-online-class-open-all

Tashakkori, A., and Teddlie, C. (1998). *Mixed Methodology: Combining Qualitiative and Quantitative Approaches*. Thousand Oaks: Sage Publications Ltd.

Trowler, V. (2010). *Student engagement literature review*. Retrieved from http://www-new2.heacademy.ac.uk/assets/documents/studentengagement/StudentEngagementLiteratureReview.pdf

Tseng, S.-F., Tsao, Y.-W., Yu, L.-C., Chan, C.-L., and Lai, K. R. (2016). Who will pass? Analyzing learner behaviors in MOOCs. *Research and Practice in Technology Enhanced Learning*,

*11*(1), 1–11. https://doi.org/10.1186/s41039-016-0033-5

Tu, C., and McIsaac, M. (2000). An examination of social presence to increase interaction in online classes. *American Journal of Distance Education*, *16*.

Veletsianos, G., Collier, A., and Schneider, E. (2015). Digging deeper into learners' experiences in MOOCs: Participation in social networks outside of MOOCs, notetaking and contexts surrounding content consumption. *British Journal of Educational Technology*, *46*(3), 570–587. https://doi.org/10.1111/bjet.12297

Vida Fernández, J., and Webster, S. (2014). From OCW to MOOC: Deployment of OERs in a Massive Open Online Course. The Experience of Universidad Carlos III de Madrid (UC3M) De OCW para MOOC: Implantação de OERs em um Curso Online Aberto e Massivo. - A Experiência da Universidad Carlos III de Madrid. *Open Praxis*, *6*(2), 145–158. https://doi.org/10.5944/openpraxis.6.2.115

Wallace, R. M. (2003). Online Learning in Higher Education: a review of research on interactions among teachers and students. *Education, Communication and Information*, *3*(2), 241–280. https://doi.org/10.1080/14636310303143

Wang, Z., Anderson, T., Chen, L., and Barbera, E. (2017). Interaction pattern analysis in cMOOCs based on the connectivist interaction and engagement framework. *British Journal of Educational Technology*, *48*(2), 683–699. https://doi.org/10.1111/bjet.12433

Wasserman, S., and Faust, K. (1994). *Social Network Analysis: Methods and Applications*. Cambridge University Press.

Watters, A. (2012). Top Ed-Tech Trends of 2012: MOOCs. Retrieved May 13, 2013, from http://scholar.google.com/scholar?hl=enandbtnG=Searchandq=intitle:Top+Ed-

Tech+Trends+of+2012+MOOCs#0

Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press.

Williams, D. (2006). On and Off the 'Net: Scales for Social Capital in an Online Era. *Journal of Computer-Mediated Communication*, *11*(2), 593–628. https://doi.org/10.1111/j.1083-6101.2006.00029.x

Wise, A. F., and Chiu, M. M. (2011). Analyzing temporal patterns of knowledge construction in a role-based online discussion. *International Journal of Computer-Supported Collaborative Learning*, *6*(3), 445–470. https://doi.org/10.1007/s11412-011-9120-1

Wise, A. F., and Cui, Y. (2018a). Learning communities in the crowd: Characteristics of content related interactions and social relationships in MOOC discussion forums. *Computers and Education*, *122*. https://doi.org/10.1016/j.compedu.2018.03.021

Wise, A. F., and Cui, Y. (2018b). Unpacking the relationship between discussion forum participation and learning in MOOCs: Content is key. *ACM International Conference Proceeding Series*, 330–339. https://doi.org/10.1145/3170358.3170403

Wise, A. F., and Paulus, T. (2016). Analysing Learning in Online Discussions. In C. Haythornthwaite, R. Andrews, J. Fransman, and E. Meyers (Eds.), *The SAGE Handbook of E-learning Research*. Sage Publications Ltd.

Wu, T., Yao, Y., Duan, Y., Fan, X., and Qu, H. (2016). NetworkSeer: Visual analysis for social network in MOOCs. *IEEE Pacific Visualization Symposium*, *2016-May*, 194–198. https://doi.org/10.1109/PACIFICVIS.2016.7465269

Zenios, M. (2011). Epistemic activities and collaborative learning: towards an analytical model for studying knowledge construction in networked learning settings. *Journal of*

*Computer Assisted Learning*, *27*(3), 259–268. https://doi.org/10.1111/j.1365-2729.2010.00394.x

# Appendix 1

The table below provides an overview of the degree centrality measure output from UCINET for Course 1.

**Table 31**

*Descriptive statistics of degree centrality for Course 1*

| | **Degree** |
|---|---|
| Mean | 664.367 |
| Standard Deviation | 390.918 |
| Sum | 358758.000 |
| Minimum | 1.000 |
| Maximum | 2290.000 |
| Number of Object | 540.000 |

# Appendix 2

Example of initial coding from the IAM content analysis

***Participant 6118f8***

| What is Culture? | PHASE I | PHASE II | PHASE III | PHASE IV | PHASE V |
|---|---|---|---|---|---|
| To my opinion, culture may now be regarded as the set of distinctive spiritual, material, intellectual and emotional features that characterize a society or social group. It includes not only the arts, humanities and sciences, ways of life, the fundamental rights of the human being, value systems, traditions and beliefs. | x | | | | |
| Oh of course every nations has own unique culture, belief and traditions.Thanks. | | x | | | |
| As others have said, culture is the combination of values and behaviour between people in a same geographic or economic space. the different values and behaviours makes differents the cultures and they establish the relation between people as friends or family. | | x | | | |
| I agree with you about the combination, but how could you find out the culture could be only based on same geographic area? In my opinion, we might only be possible to know the similar living style or quality in a same geographic area. | | | x | | |
| I believe that both of National and Organisational cultures. I remember that long time ago I came to Russia I was so shocked culture of behaviours people and customs of Russia. It would be " National cultures". When I start to work for mining company they have strict rules and procedures of safety in every office and department. My previous company was not like that and I was so shocked at my new company rules and procedures. Of course, it would be organisational customs. Thank you for your attention. It is always feel free to tell me your opinion on my note. Thank you. | | x | | | |
| Where was your first company based? | | x | | | |
| I have lived many years in Russia and I was surprised by the difference of culture at work or in public compared to culture in private (home or among friends). This made clear the difference between an institutional culture people just follow or | | x | | | |

| | | | | | |
|---|---|---|---|---|---|
| have to accept and private culture people really embrace but do not (dare to) expose in public. | | | | | |
| I'm from Russia and even for Russian people are also not so easy to understand behaviour of some surrounded people. In additional I'd like to make a note that mostly people in Russia are quite smart, intelligent and clever. It depends only on family where child grew. | | x | | | |

Pattern: 1223**3**1221

| What is Culture? | PHASE I | PHASE II | PHASE III | PHASE IV | PHASE V |
|---|---|---|---|---|---|
| I believe that culture is "same mind set of people in every aspect of their community or organization or country". | x | | | | |
| Culture is something really unique, tangible and intangible at the same time. Like many above me has summed up and also mentioned in the lecture, culture is not a single "thing", it's a collection of various aspect of a society: values, beliefs, religion, behaviours, traditions, history etc... the list could go on forever. In my opinion, defining the "what" is not as important as the "how", how will you adapt and blend into a certain culture if you are required to. It does obviously take time and effort to achieve that, especially if the foreign culture carries some opposite meaning to your own culture, which has been nourished in you since childhood. That is a really important and relevant question that each individual needs to find his/her own answer in this nowadays globalized world. | | x | | | |
| I agree with the given definitions: Culture is the set of all the life forms and expressions of a given society. And you can see one part of that, some of behaviours and customs but when we look deeper (to beliefs and attitudes) we can understand them and to set aside prejudices and other concerned distorsions. | | | x | | |
| In my opinion, the definition of culture is a way for any specific groups to express how their values, beliefs, customs could be understood. Since people are all different, meaning that the culture could be different among no matter a person or group. Since then, there is no right dimensions on which cultures should be accepted or rejected. Therefore, this builds up a global socialized and intercultural world for everyone, such as you and I whatever our cultural framework is. | x | | | | |

| | | | | | |
|---|---|---|---|---|---|
| In my opinion,culture contains complex meaning which relates to so many other elements such as environment,geography,religion,custom,morality and so on. | x | | | | |
| Hi all!! Is very diffcult explain what culture means, in my opinion, culture is a mixture of thoughts, believes, experiences.. It's static because depending on how we life our lives it changes, enriches. | x | | | | |
| It's not easy to define culture which is considered as a complex concept. To make it easily understandable, Culture is the systems of values, attitudes and beliefs shared by a relatively large group of people. People within the same culture have the behaviours and customs in common. We need to be aware of intercultural framework if we want to communicate effectively with others in different culture. | x | | | | |

Pattern: 1231111

| High-Context and Low-Context Cultures | PHASE I | PHASE II | PHASE III | PHASE IV | PHASE V |
|---|---|---|---|---|---|
| Hello I am from Japan. I think from my experience , Japanase are very true on high-context type.<br>People in Japan are very humble, do not insist our opinion strongly. They tend to talk about anything indirectly. Japanese are very mindful of the action , atmosphere of the people first to see to judge whethere acceptable or not. I takes time to make relationship with other Japanese , beacuse they do not try to act friendly to open communication easpecially for foreign people. Once having a strong relationship with them(Japanese), they are sure to help as a member of community. Such high-context is coming from the culture that Japan is island nation apart from continents, that make Japan keep away from immigration or foreign culture past days. | x | | | | |
| I live in Italy, which is listed in the middle of the chart. I agree with that because we can easily go from peaches to coconuts. It all depends form tradition and customs, but it is absolutely true that we use a lot of non-verbal communication ;) | x | | | | |
| In Thailand, we are categorized as high-context cultures also because most of them | x | | | | |

| | | | | | |
|---|---|---|---|---|---|
| don't like to say sth frankly,they often prefer dancing around the subject first to be more polite and a lot of them choose to not saying instead of saying sth very direct. | | | | | |
| I did not see China on the chart, but I do believe that is closer to the high-context. Chinese usually speaks very not clearly to bring out the meaning what they tell, but they are more preferring the listeners to guess the meanings. | x | | | | |
| Hi, Im Rhod and I am from the Philippines. Ours is an asian country and my family members and I agree to the opinion that Philippines is a High Context Culture.<br><br>As previously discussed, among the characteristics of a high context culture are:<br><br>1. Value is placed in relationships- Yes, I agree.In fact we have this unique way in expresing our respect to the person with whom we are speaking to, we often include the words "po" and "opo" to appropriate places within a sentence to show respect. We usually do this when we are speaking before someone older or someone with authority.<br>Interestingly, this is also an unspoken rule when younger men talks to someone older.<br><br>1. Tendency to be more indirect- Yes, I agree in this point as well. A perfect example is the way I communicate with clients of our firm. In emails, I have have done something beneficial to the client, it is an unwritten rule not to get the credit for yourself, but accept the credit in behalf of the firm. I do that by saying, "We were able to accomplish..."<br>I cannot really say for certain that Hall's Cultural Context is valid universally, but I have the opinion that in so far as my viewpoint is concerned, it is generally true. | | | x | | |
| Hello Everyone, It is very interesting and I need to say that this help me a lot to understand my own difficulties!!! My family is Algerian and I was born in France with an Arabic education which means indirect | | x | | | |

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| communications. In France, it is true that we often use direct communications and the objectif of the meeting needs to be based on a clear TO DO LIST. During the meetings, you often have to argue for your ideas directly regardless to harmony in the group. This is very difficult for me since I have been educated in my family nether to argue in front of Public and always use insunuations to make people undrstaood that they might be wrong... Hes everyone else experience this in their country. Have a nice day !! Nainly | | | | | |
| Hello everybody. I'm from Ukraine and as i see it, we are representatives of coconut culture. Despite of this fact we are smiling and trying to be friendly with strangers or new acquitances, but not intended to ask or answer perrsonal question from the beginning. I didn't find my country in the diagram High-low context cultures. But i may assume we are belong to high context culture. | x | | | | |
| I am from Chile. We have mostly a high-context culture! We are used to be more indirect than direct to talk to other.We care a lot about relationships. I should say that i had the opportunity to be in US and to share quite often with people from Europe (Germany, england, netherlands, france mainly) and it was really surprise to me how direct they are. At the same i had the opportunity to share with people from Brasil, and as you can imagine, i could realize how similar we are about how we see relationships. | x | | | | |