Review article

Connectivism and leadership: harnessing a learning theory for the digital age to redefine leadership in the twenty-first century

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ABSTRACT

This manuscript provides a literature review of connectivism. It presents evidence and thinking in which connectivism, a new learning theory which has typically been used for online learning, is applied to leadership, with a provocative discussion on the yet unexplored opportunities to use connectivism to redefine leadership in the twenty-first century. The paper aims to bridge the gap between the contributions of digital learning in education and the field of leadership theory and development. It seeks to apply the critical tenants of connectivism in education and learning to leadership theory and to stimulate a debate on new forms of leadership.

1. Introduction

The concept of connectivism describes the nexus between human learning and the ubiquitous access to knowledge enabled by the current technological environment. Although connectivism has been largely associated with adult learning theory, there is a belief that it can also be considered as a key factor in organizational leadership theory. The central theme of this literature review focuses on a summary, evaluation, and analysis of the available literature related to connectivism, both as it relates to adult learning theory and to organizational leadership theory.

Specifically, the authors aim to encourage a critical inquiry into the ways connectivism can inform and redefine effective organizational leadership. As the logic of networked information technology for understanding learning theory advances, it can also furnish researchers and practitioners a new perspective in the ontology with connectivist principles to re-examine leadership.

The structure of this manuscript is divided into three parts. In the materials and methods section, the authors examine the development of connectivism (Downes, 2007; Siemens, 2005a) looking back at the established theories of learning that preceded it (behaviorism, cognitivism, and constructivism) and the theorists who informed its design (Hare and Papert, 1991; Lave and Wenger, 1991; Moll, 1990; van Gelder and Clark, 1998).

Then, the literature review outlines the fundamentals of connectivism to include its main principles, originality, and modes of interactions and engagement with teachers and learners. The second section explores the results of connectivism, its impact, and the practical applications it has had to date.

Finally, the last section provides a discussion on the wide-ranging implications of connectivism with an examination into whether connectivism can be considered a new learning theory per se, and the authors suggest some yet unexplored opportunities to apply connectivism in redefining leadership in the twenty-first century.

2. Materials and methods

This paper uses a literature review as its foundation and was constructed by searching academic papers, journal articles, and other scholarly publications for works related directly and indirectly to the subject of connectivism. Of particular interest were works describing the evolution of traditional learning theories that could ultimately influence the development of connectivism theory, as well as works that describe current perceptions of connectivist theory as it applies to adult learning and organizational leadership theory and practice.

2.1. A historical perspective of connectivism

2.1.1. The evolution of connectivism from traditional learning theories

Learning theories. Understanding why and how people learn is a significant area of inquiry. According to Grassian and Kaplowitz (2009), theories of learning aim to provide a foundational approach for instructional design and aid educators in creating successful learning environments so young and adult learners can maximize their instructional experiences. Learning theories also help explain the reasons for changes in learning and performance outcomes (Driscoll, 2000). Above all, learning theories provide insight into the critical thinking and self-development ability and growth of humanity in general. According to Knowles et al. (2005, p. 10), "a theory is a comprehensive coherent and internally consistent system of ideas about a set of phenomena." A theory provides a starting point for initial conjectures (Kid, 1973), a way to order ideas and facts (Bower and Hilgard, 1981) and to assemble hypotheses and postulates (McGregor, 1957) into a coordinated approach. When applied to how people learn, theories of learning account for how the learning process takes place and provide guidelines for action to improve successful learning. Learning theorists saw learning as "a process by which behavior is changed, shaped or controlled" due to experience (Knowles et al., 2005, p. 13). Duke et al. (2013, p. 6) explained that "a learning theory tries to classify what is known about learning" by providing both a vocabulary and a conceptual framework that researchers can use to describe what they observe and to problem solve.

Throughout history, various theories have proliferated to help inform the understanding of learning. Thus, Knowles et al. (2005) proposed classifying contributors within two main groups: behaviorist/connectionist theories, and cognitive/gestalt theories. Most learning theories categorized learning into two opposing views of knowledge acquisition: either as an externally-driven process (behaviorist, connectionist) or as an internally-driven one (cognitive, control theory, neuroscience, brain-based learning). According to learning theorists aligned to behaviorism (Fearing et al., 1929; Guthrie, 1952; Hull, 1944), reality was external to the mind and knowledge was acquired experientially. As such, learning occurred as a response to an external stimulus with influencing factors such as rewards and punishment. Learning was task-based with hardwiring in memory seen as a "black box" for understanding and remembering behaviors.

Conversely, learning theorists anchored in a cognitivism approach (Bruner, 1961; Gagné, 1965) looked at learning as a structured computational process of acquiring and storing information, focused on the internal aspects of learning. Influencing factors were existing schema and previous experiences with memory allowing information encoding, storing, and retrieval. Rather than tasks, knowledge was about problem-solving, intelligence, motivation, interest, concentration, and reasoning. The development of connectivism was a further evolution of all these traditional learning approaches by connecting learning to both internal and external dimensions of life inseparable from the technological innovations that enabled it.

2.1.2. Pre-connectivist theories of learning

Knowledge environments. In his description of social constructivism, Vygotsky (Moll, 1990) bridged the relationship between knowledge environments (internal and external), which is thought to have significantly influenced connectivism. Jaramillo (1996, p. 136) noted that "unlike behaviorist and sensationalists, Vygotsky stressed that the mind and body of the subject are joined and that this connection is further expressed between the subject and objects in his environment (Moll, 1990)." Vygotsky determined that "language" and "scaffolding" were two central components in the learning process, which allowed learners' cognitive development to occur through both individual and external knowledge. apert (Hare and Papert, 1991) defined learning as a relationship between the individual and his or her environment. Largely known for "Constructionism" rather than "Constructivism," Papert (Hare and Papert,

1991) based his ideas upon the notion that experimentation led to learning through physical construction. He argued that constructing a subjective reality through experimentation and activity was paramount to learning. Engagement, participation, social, and cultural context all allowed personal and social meaning to be created from which learning occurred. Authors van Gelder and Clark (1998) further built on Papert's approach contending that language provided interactions between the mind, brain, and the environment where the source of cognition resulted. With these early influences, connectivism reconciled knowledge as both an internal and external process.

The Social nature of learning. Connectivism also benefited from the concepts of situated learning and of communities of practice (Lave and Wenger, 1991), which recognized not only the power of networking technologies for learning but also the social process of knowledge creation and sharing. According to Matusov et al. (1994, p. 918) "Lave and Wenger's book provides a reconceptualization of learning as a process of social and personal transformation in communities of practice." Lave and Wenger saw the acquisition of knowledge as heavily influenced by membership and social interaction within communities. Envisioning communities as virtual entities in which the communication and interaction of members could be facilitated technologically provided a stepping stone to the technology-centric design of connectivism. Learners needed to negotiate their participation in communities through situated and group learning. This sociocultural approach to learning was a landmark in reconceptualizing individual learning into community participation.

2.1.3. The birth of connectivism

George Siemens first introduced connectivism in a seminal online article originally written on December 12, 2004, and then updated on April 5, 2005, where he called it "a learning theory for the digital age" (Siemens, 2005a, p. 1). He firmly anchored his theory against other traditional learning theories, which he described as inadequate in the face of new and revolutionary social networking technologies affecting searching, research, teaching, and learning, along with numerous other aspects of daily life. Siemens (2005a, p. 1) notes that "over the last twenty years, technology has reorganized how we live, how we communicate, and how we learn. Learning needs and theories that describe learning principles and processes should be reflective of underlying social environments." Henceforth, from its early beginnings, connectivism was positioned as an alternative learning theory more consistent with the changing environment and the natural and logical response to significant technological shifts affecting learning. Connectivism produces an examination of technology trends, the evolution of learning, changes in organizations, and the nature and source of knowledge.

Much of Siemens' paper reviews the limitations of previous learning theories which he saw as inadequate because they were predicated on learning occurring inside a person when he contends that technology and data systems allow learning to happen outside of the brain, in computers and databases. Connectivism leverages networking as the basis for knowledge creation. Individuals feed internal information to a learning community and connect to nodes from a more extensive, diverse network (Siemens, 2005a). Siemens also critiques traditional learning theories for being too abstract and failing to describe how learning develops in organizations. Connectivism defines learning as a networked group effort where learning is a process of connecting people and information sources. Duke et al. (2013, p. 6) explain that "stated simply, connectivism is social learning that is networked." As such, "connectivism is therefore considered to represent a successor to theories such as cognitivism, constructivism and behaviorism" (Garcia et al., 2015, p. 880).

Siemens (2005a, p. 4) introduces connectivism as "the integration of principles explored by chaos, network, and complexity and self-organization theories." From there, he articulates the principles of connectivism harnessing original and provocative ideas from interdisciplinary fields in technology, networking, leadership, and social sciences. Siemens describes connectivism "as an integration of principles explored

by myriad theories" (Dunaway, 2011, p. 676), which incorporate previous thinking such as social constructivism (Moll, 1990) and then more modern theories such as network theory (Barabási, 2005). Finally, Siemens (2005a) offers some thoughts on the implications of connectivism. Beyond redefining learning, Siemens (2005a, p. 5) notes that connectivism has "implications for all aspects of life" including management and leadership, the media industry, and organizational knowledge management. This first conceptual essay denounces the boundaries of other learning theories and proposes a radical view of learning connected to networked information technology. It establishes a strong point of view on distributed knowledge and builds on contemporary learning theories focused on the social nature of learning with social negotiation, participation but also connection and networking.

In a later paper entitled *Connectivism: Learning as Network-Creation*, Siemens (2005b, para. 3) expands on his initial concept providing more in-depth information on what is a network, the process of network formation, the definition of network nodes and presenting learning definitely as "a connection-forming (network-creation) process." Siemens (2005b) outlines the characteristics of learning networks using attributes from sociology and physics (i.e., small world effect, weak ties, centrality, control, and knowledge flow) to explain the concept of networked learning. The paper concludes with a description of the transformed "knowledge ecology" which Siemens (2005b) describes as having evolved from a formal, linear and sequential process to a dynamic connection-based approach focused on organizing learning within a network. The following year, Siemens published a book entitled *Knowing Knowledge* (Siemens, 2006) which aimed to firmly establish connectivism as a learning theory. He provides a full historical analysis on the evolution of knowledge, a review of trends guiding the move toward new forms of learning, an implementation model for his proposed theory, and the Connectivism Development Cycle (CDC) to help transform instructional and organizational designs based on the changed context of knowledge.

2.1.4. Trajectory

Stephen Downes also significantly contributed to the conversation on connectivism stating that "at its heart, connectivism is the thesis that knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks" (Downes, 2007, para. 1). In *An Introduction to Connective Knowledge,* Downes (2008) introduces the reader to a new connective form of knowledge and gives a technical perspective on the different types of knowledge – qualitative, quantitative and connective (distributed) – with the structure of connections in networks, and a description of how networks function. Similar to Siemens, Downes aims to depart from traditional learning theories with the added perspective of the connected age and a desire "to find a new renaissance" for knowledge (Downes, 2008, p. 100).

Beyond Siemens and Downes who are considered the originators of connectivism, authors who most contributed to the body of work on the subject include those who explicitly questioned it as a theory (Ally, 2008; Kerr, 2006; Kop and Hill, 2008; Verhagen, 2006). Connectivism also greatly benefited from enthusiastic practitioners who applied connectivism to Massive Open Online Courses (MOOCs), helping to provide validity on its merits and acceptance as a useful learning theory.

3. Results

3.1. Principles and foundations of connectivism

3.1.1. Principles

Siemens (2005a, p. 4) describes the basic principles of connectivism as follows:

- Learning and knowledge rest in diversity of opinions.

- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.
- The capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections is needed to facilitate continual learning.
- The ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

These principles present not only a new model of learning (as to how and where learning occurs) but also a new perspective on knowledge itself that "acknowledges the tectonic shifts in society… learning skills and tasks needed for learners in a digital era" Siemens (2005a, p. 5).

3.1.2. Foundations

Connectivism, outlines four foundations for learning, which include autonomy, connectedness, diversity, and openness.

Autonomy. Autonomy refers to what is self-governing and comes from Greek roots meaning "self," and "independent" (Online Etymology Dictionary, n.d.). In connectivism, it pertains to how self-directed learners behave toward their own learning. They are expected to choose their own connections and relevant information sources without being guided by the traditional instructional process. As a result, learners minimize the control and power structure of teachers and can gain autonomy for their own knowledge, its distribution, and velocity. Siemens (2005b, para. 13) describes the importance of motivation in creating receptivity to network learning based on the "desire to foster deep network connections" based on emotions, reflection, logic, and reasoning.

Connectedness. Within the field of psychology, connectedness relates to sociability and relatedness, while in connectivism, the concept recognizes that knowledge is about the networked connections of people and computers. Connectivism emphasizes how critical information from networked sources is within the process of learning: "the idea that learning takes place across networked learning communities and information technologies is central to connectivism" (Dunaway, 2011, p. 675). Within connectivism, learning occurs when peers are connected and share opinions, viewpoints, and ideas through a collaborative process. While teachers are participants in the network, they fulfill a different role than that of the teacher per se and become more of a connected peer, rather than an authority figure who controls the interactions.

Diversity. Typically, defined in light of demographic diversity (gender, race, culture, socioeconomic status, etc.), diversity in connectivism represents the unique perspectives and creativity of members in the network who are contributing to the whole. tudents are encouraged to seek the opinions, suggestions, and ideas of others, as teachers no longer provide a single source of knowledge and expertise. According to Downes (2012), the educational system and its resources should maximize diversity.

Openness. Related to curiosity, exploration, and creativity, openness in the context of connectivism is seen as the exchange of ideas, resources, and artifacts within the network system. People can choose to opt in or out of the network allowing open engagement with the network based on the individual's pace, preferences and desire to participate.

Based on these four key principles of learning, Natt och Dag (2017, p. 302) contends that connectivism has some similarities with the principles of adult learning. It was noted that "the main difference between adult learning and connectivism, however, is that whereas adult learning

principles focus on the individual learner, connectivism focuses on the aspect of connectivity, and how the learner himself or herself connects the nodes."

3.2. Connectivist views on learning, knowledge, reasoning, and interactions

Adult learning theory focuses heavily on the concepts of learning as a process used in the acquisition of knowledge, and the application of that knowledge occurring through reasoning. When viewed through the lens of connectivist theory, the concepts of learning, knowledge, and reasoning are seen in a somewhat different context.

3.2.1. Learning

Connectivism states that two critical factors contribute to learning: searching for new information and filtering superfluous data. Therefore, making decisions based on information is considered a cornerstone of the learning process (Kop and Hill, 2008). Anderson and Dron (2011, p. 4) observe that "connectivism assumes that information is abundant and that the learner's role is not to memorize or even understand everything, but to have the capacity to find and apply knowledge when and where it is needed." In fact, Siemens (2006, p. 10) asserts that "the ability to see connections between fields, ideas, and concepts is a core skill" and he further explains that "learning is the act of recognizing patterns shaped by complex networks." In addition, connectivism argues that problem-solving could be managed by machines, leading to Siemens's controversial notion that non-human environments such as databases and computers could also facilitate human learning as well. This possibility opens up many new opportunities to explore connectivist learning with artificial intelligence.

3.2.2. Knowledge

The connectivist model views knowledge as a distributed information network. It acknowledges the increasing advancements in technology and their impact on altering the state of knowledge acquisition. In connectivism, knowledge shifts from within the limited range of a learner's brain to outside of the learner, with the individual gaining access to information residing anywhere on the network. Pegrum (2009) equally observed that the network, more so than the individual, was the resting place of knowledge. The cycle of knowledge is thus extended to a system of networks where outside knowledge and connections enrich any knowledge, turning knowledge acquisition from a personal process to a collective continual learning cycle. Downes (2007, para. 1) defines connectivism as "the thesis that knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks." Downes (2007, para. 6) further explains that "in connectivism, there is no real concept of transferring knowledge, making knowledge, or building knowledge. Rather, the activities we undertake when we conduct practices to learn are more like growing or developing ourselves and our society in certain (connected) ways." As a result, connectivism proposes a new paradigm for knowledge that challenges not only where knowledge has traditionally been thought to reside (from either outside or inside the brain, to both inside and outside), but also with whom it resides (from just within an individual, to humans and machines).

3.2.3. Reasoning

As a result of this form of learning and point of view on knowledge, connectivism proposes a radically different way of reasoning based on the management of information. In connectivism:

Learners encourage each other to be involved in networks, internet use, and to make use of their sense-making (metacognition skills - thinking how to think), patterning (knowledge/pattern recognition), and way-finding (identifying one's goals and mission through those networks and community involvement) and realizing the emergent knowledge (ontology – learning to be) through an integration of information learning with their formal education (Heick, n.d., para. 1).

3.2.4. Interactions and engagement

Traditional learning theory typically views interactions between learners and instructors and between learners and their peers. Connectivist theory views the roles and interactions between teachers, learners, and their peers from a somewhat different perspective.

Teacher role. Connectivism suggests that competence comes from forming connections within a network. The teacher no longer has control or superior knowledge to tell the learners what to do. In connectivism, the teacher functions as a peer, a moderator, and facilitator instead of a formal instructor. It is assumed that no one person can hold all the knowledge and that instead, teams can provide a way to manage the increased complexity surrounding knowledge, learning, and decision-making. Karen Stephenson, an influential social network theorist who developed the quantum theory of trust, described this through the view that "other people, become the surrogate for knowledge. *'I store my knowledge in my friends'* is an axiom for collecting knowledge through collecting people" (Gross, 2011, p. 147).

Learner role. In connectivism, the learner contributes to a learner community by learning from it, connecting to it and sharing information with it. Nodes, which can include people, their feelings as well as information and data, connect various elements of the larger network together. Siemens (2006, p. 10) argues that "knowledge does not only reside in the mind of an individual, knowledge resides in a distributed manner across a network." As a result of these changing views on the interaction and engagement of teachers and learners, a blurring of the lines has occurred between both roles, which led Siemens to provocatively state that "the learner is the teacher is the learner" (Siemens, 2006, p. 42). No one person, either teacher or learner, can contribute to the success of learning and the knowledge creation, given how distributed and widespread knowledge has become in the digital age. The network itself becomes the content provider and cognitive element capable of processing, guiding, filtering, and evaluating new and relevant information. As such, the network value in Siemen's learning ecology becomes omnipresent and multi-dimensional.

3.3. Connectivism as a learning theory

Connectivism has witnessed criticism, debate, and discussion about its validity as a learning theory. Theorists have provided various criteria that should be met to make a learning theory eligible, which include:

- It must be useful for explaining and predicting behavior (Duke et al., 2013);
- It should include clear assumptions, beliefs and key terms about the subject of the theory (Gredler, 2009);
- There should be a defined specific boundary (Skinner, 1954);
- The new theory replaces previous theories that have become inferior (Kerr, 2006);
- It has the ability to be tested, refined, and even disproved (Dorin et al., 1989).

To meet these criteria, theorists have promoted the need for a learning theory to undergo a considerable amount of inspection with testing and evaluation of its falsiability (Ertmer and Newby, 1993) and adherence to the rule of parsimony (Johnson and Christensen, 2008).

3.3.1. Supporters of connectivist learning theory

Arguments in favor of connectivism to be considered a learning theory have mostly rallied around its usefulness, explicit assumptions, and beliefs. The comprehensive, coherent, and internally consistent set of ideas on how the cycle of knowledge occurs within a system of networks

is original and novel. Connectivism has explained how people learn through the creation of personal networks. It has also set a guide for action on how connections between information sources facilitate always-on learning while creating a new environment for learning and thinking. Connectivism has borrowed key terms from other theories (i.e., network theory) and thus enriched the study of learning with new language traditionally not applied to the field of learning theory.

3.3.2. Opposition to connectivist learning theory

Criteria that are inconsistent with connectivism as a learning theory have included its lack of boundary as a major flaw. While connectivism has offered many good explanations for learning as phenomena and methods to encourage change in human capability, it has blended principles from a myriad of other learning theories which renders its specific contributions harder to determine. Kerr (2006, para. 5–7) criticizes connectivism on this basis saying that it "misrepresents the current state of established alternative learning theories such as constructivism, behaviorism and cognitivism, so this basis for a new theory is also dubious." Kerr (2006) also argues that connectivism was subsumed in existing learning theories and merely provided a point of view on the emergence of networking technologies that affected learning in new ways.

Similarly, Ally (2008) agreed that connectivism could be used alongside previous learning theories to determine the applications of networked learning, but he rejects that it is a learning theory distinct in itself. Verhagen (2006) criticizes connectivism for being an unsubstantiated philosophy and is of the view that it is a pedagogical approach, more so than a theory of learning. Finally, connectivism received criticism that it lacked in research evaluation and testing. Much of the literature on connectivism is anecdotally found online in blogs and Internet discussions, which are not theoretically based. No scientific research or scientific methods exist to prove or disprove the theory of connectivism. Indeed, Kop and Hill (2008) remark that Downes's theory of distributed knowledge (2008, p. 3) has "not yet fully extended from the philosophical domain into that of applied research" and that Siemens's connectivist model is "a ripe training ground for further studies."

While the aforementioned criticisms are valid, they mostly evaluate connectivism within the narrow boundaries of other more traditional and confined learning theories, rather than explore its merits to enrich other fields that are impacted by digital knowledge and transformation. Undeniably, connectivism redefines knowledge in the context of modern-day technology disruptions in a way that is far more insightful than any other modern learning theory. Primary applied research with a focus on connectivism can help to prove its usefulness as a theory, above and beyond just its contributions to the field of learning, and its applicability to the real world with well-substantiated explanations of some of the aspects of its guiding principles.

4. Discussion

4.1. Applications of connectivism for learning

While the ideas of connectivism might have been radical, shocking, controversial, and somewhat nebulous ten years ago, there is greater understanding, if not growing acceptance, of their merits today. "Connectivism acknowledges the role of information technology in the process of accessing information from multiple sources and the development of skills for evaluating connections between different information sources in a dynamic information network" (Dunaway, 2011, p. 675). Given the rapid and continuous acceleration of networking technologies in all aspects of our lives, the recognition of the phenomenon of connectivism promises to be highly pertinent.

By explaining how new generations learn with regard to emerging technologies in both instruction and curriculum, connectivism has had a strong impact on inspiring and guiding practitioners to higher standards and has "forced educators to look at what is being done in digital

education and rethink, debate, and philosophize over how each part fits" (Duke et al., 2013, p.10). According to Kop and Hill (2008, p. 4), "where connectivism draws its strength is through using Web-based activity as an example of learning looking through the connectivist lens. The analogy is intuitive and powerful because of the ubiquitous use of the Internet in today's world."

4.1.1. Massive Open Online Courses (MOOCs)

The practical application of connectivism can be best seen in distance educational practices with the development of Massive Open Online Courses (MOOCs). Directly conceptualized by Siemens and Downes, MOOCs were created to bring a large number of people together and connect them as a huge network for learning, putting into practice connectivism. According to Goldie (2016), the first MOOC created in 2008 on the subject of "Connectivism and Connected Knowledge" included more than two thousand participants worldwide. The subsequent designs and outcomes of many MOOCs since 2008 have helped bring to life and validate the following principles of connectivism:

- Autonomy: teachers play the role of facilitators but are not the sole source of knowledge in the learning process. Learners are given complete autonomy and the choice of technology tools to use (RSS feeds, threaded discussions, blog posts, a virtual game, and synchronous online meetings);
- Connectedness: connections and contributions are encouraged via digital platforms including blogs and social media, and sharing is enabled via aggregated tweets placed in a daily digest email and newsletter;
- Diversity: students are encouraged to seek the opinions of others as teachers no longer provide the single source of knowledge and expertise;
- Openness: MOOCs are online, many of which offered as free courses that attract thousands of participants from all around the world. In this sense, they are open and massive in scale.

Kop and Hill (2008, p. 3) relate three challenges with connectivist learning in MOOCs: (1) how critical literacies are developed and the power relations within the network; (2) the extent to which learners have autonomy; and (3) presence.

Critical literacies. MOOCs require a level of critical literacies to guarantee that participants have enough experience online to participate in learning activities. This includes the confidence and competence to use the tools provided to engage meaningfully within the online community. The rapid growth of this form of learning will no doubt contribute to educating a new generation of learners that have inbuilt abilities as digital natives. While MOOCs have been available for the last decade, many top universities offer this form of education with access to classes at no charge, providing millions of individuals the opportunity to gain cutting-edge computer skills, as well as the formal education they might otherwise not be able to afford. In 2012, two university students from Stanford University created a MOOC on artificial intelligence, which attracted over 160,000 students from 190 globally (Goldie, 2016). Steffens (2015) recounts how in 2013, the European Commission started to promote education leveraging MOOCs which resulted in the launch of "Openup Ed" by a group of European Universities. By 2014, over six hundred MOOCs had been delivered by thirty-three European universities. According to Lange (2015, p. 97), the increasing popularity of MOOCs is creating a "borderless distribution of knowledge via MOOCs."

Learner autonomy. With networked learning, participants need to be able to take charge of their own learning. This can take time, especially to build a sufficiently comfortable level to navigate in an autonomous fashion as well as get involved in collaboration and creative tasks. Some studies such as Karsenti (2013) have found that MOOCs have the potential to encourage student autonomy. Shulze et al., 2016 examine the relationship between self-directed learning and successful MOOC completion, noting that self-directed learners tend to be the most likely to

successfully complete MOOCs given their persistence. Lange (2015, p. 96) discusses how MOOCs challenge the traditional approach to higher education by not only commoditizing the distribution of content and knowledge but also by placing "knowledge away from the 'professor' towards network users and contributors." Goldie (2016, p. 1067) adds that "despite its limitations, most authors recognize connectivism's potential to provide a useful perspective…its relevance at the curricular level contributing to new pedagogies in environments where control is shifting from the tutor to more autonomous learners." Finally, Downes (2012) also observes that open source software is often developed directly by MOOC users, indicating that MOOCs not only promote learner autonomy toward the curriculum but also regarding the delivery systems of the classes themselves.

Presence. Kop (2011, p. 9) explains that MOOCs need to pay special attention to the conditions that can encourage people's ability to engage including "the "social presence" of the facilitators and of participants, which enhance the 'community' forming and the sense of belonging that built confidence and stimulated active participation."

Aside from these three challenges, research and designers Liyanagunawardena et al. (2013) highlight other issues confronted by MOOCs: (1) the difficulty of managing the various perspectives of many stakeholders during the online session; (2) tension that can arise from different pedagogies presented; (3) making ethical decisions for managing the data generated; and (4) handling the information overload and the need for self-regulation of participants.

4.1.2. Other learning applications

Other practical applications for promoting network learning via a connectivist approach have been envisaged. Medical educators have explored using innovative network technology at the classroom level to give students access to far-reaching and lesser-known medical resources by exposing them to different geographic and cultural medical practices. They also have expressed interest in using the connectivist learning approach for students to experience global medical practices enriching their observation of others in the field. Mehta et al. (2013) discussed regrouping multiple medical schools into a central online collaborative learning environment, rather than teaching the same content at multiple locations. Connectivism has also been considered to encourage multidisciplinary collaboration and learning from allied health professionals such as nurses, pharmacists, psychologists, etc. In summary, while the connectivism theory is still in its infancy stage, MOOCs have provided an exciting testing ground with the connectivist approach at a practical level. Other applications of the connectivist approach are still nascent and ongoing.

4.2. Applications of connectivism for leadership: "Connectivist Leadership"

Given the status of connectivism as a learning theory, it is our belief that connectivism is also relevant as a theory that can explain organizational learning, leading to an influence on the practice and effectiveness of organizational leadership.

4.2.1. Learning and leadership

The criticality of learning as a foundational aspect of leadership has been well documented. Kouzes and Posner (1995, p. 323) argue that "effective leaders are constantly learning. They see *all* experiences as *learning* experiences." Brown and Posner (2001) showed that learning and leadership were intricately linked. Their research reveals that leadership behaviors are proportionally linked to the level of activity and engagement of learners. Vaill (1999) notes that the current working environment is putting pressure on executives to keep up and is creating a need to constantly upgrade skills and knowledge. He further explains that "all managerial leaders are feeling a dramatic quickening in the pace of change, an increasing complexity to their choices and a greater and greater cost of being wrong" (Vaill, 1999, p. 119).

At a macroeconomic level, the emergence of the knowledge economy has meant that learning is not just "a change in human disposition or capability" (Gagné, 1965, p. 5). Rather, it is a key competitive advantage in providing the ability to add value, innovate and lead (Drucker, 1993). Kessels and Poell (2004, p. 147) remark how "in emerging knowledge economy, the character of work will change and will take on more of the nature of learning processes." Traditional notions of productivity and value are being challenged as knowledge development starts to outweigh capital, labor and the physical resources used by a company to produce its finished goods. Kogut and Zander (1996, p. 503) offer a valuable and provocative definition of a firm which they describe "as a social community specializing in the speed and efficiency in the creation and transfer of knowledge" leading to new ways of organizing people and their work output around learning. Natt och Dag (2017, p. 301) explains that "the individual learner quite simply lives in a networked reality, which necessarily affects learning at the individual as well as the organizational level and, consequently, collective learning." Furthermore, Kessel and Poell (2004, p. 147) note that "the performance of firms and institutions in the knowledge economy will be judged by their knowledge productivity." In this context, learning is no longer just a means of leading and improving performance, but the act of leading itself – learning *is* leading.

4.2.2. Connectivism and leadership

In his original paper, Siemens (2005a) posits that connectivism will have dramatic implications on management and leadership. Unfortunately, none of these ideas are outlined in any detail. This provides a rich opportunity for researchers to apply connectivism as "a learning theory for the digital age" (Siemens, 2005a, p. 1) to leadership in the digital age. If to a large extent, generations have evolved concurrently with the technologies that enabled them, it is fair to assume that leadership could equally evolve the way of learning with Web 5.0 and beyond, social networks, content aggregation, and crowd-based approaches, thus creating new forms of leadership that may be informed by the learning theory of connectivism.

From learning to leading in the digital age. Technology changes described by Siemens and Downes have accelerated in the last decade. Companies such as Facebook and Twitter are just over a decade old (founded in 2004 and 2006, respectively). The increased accessibility of information has forced educators to adapt their teaching techniques and shifted the expectations and working habits of students, thereby creating a new generation of students and workers who are conversant and demanding of technology. Networking has become pervasive in all aspects of daily life, and more modern technologies (i.e., virtual reality, augmented reality, voice recognition, and artificial intelligence) are changing organizational practices and staff habits. Digital learners comprise a new generation who are entering the workplace with markedly different expectations of work, learning, and leadership. Henceforth, it is particularly timely to impart the connectivist lens from learning onto leadership because information, knowledge, and influence are increasingly dispensed via networking technologies, providing a reference point for Siemens's and Downes's assertions. As Natt och Dag (2017, p. 295) notes, "leadership development professionals can be inspired to apply connectivism as a lens to further understand adult learning theories in the era of information and technology as well as apply it to the development of leadership programs aimed at highly skilled professional groups."

Leadership: connected, distributed, and networked. Siemens (2005a, p. 15) declares that "knowing and learning are today defined by connections" and as such, "connectivism is the assertion that learning is primarily a network-forming process." This statement could be validated equally for leadership with an investigation of how leadership is re-defined by collective connections rather than confined to an individual effort. While practitioners and researchers have long migrated away from the great man theory which defined leadership through traits and inborn characteristics (Goldberg et al., 1993; Mann, 1959) leadership has often
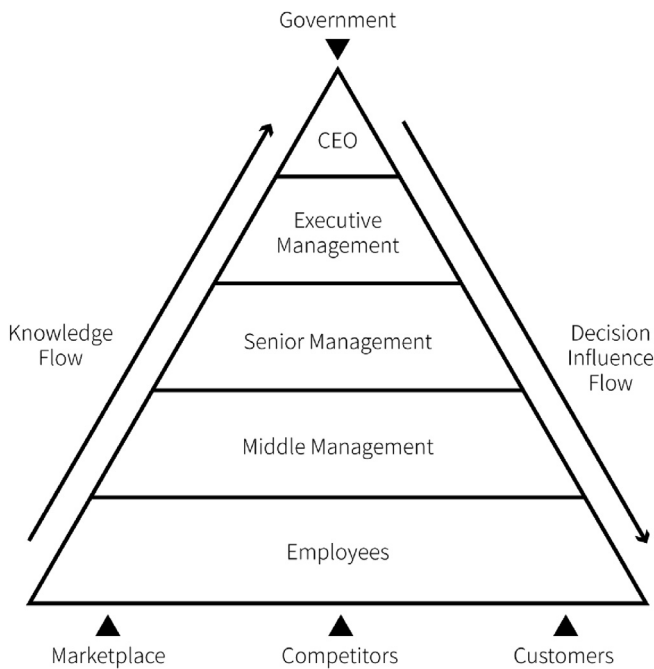
Figure 1. Hierarchical organization knowledge and decision flow.

remained confined to a singular journey. There is still widespread acceptance that leadership is a process that can be conceived as a transactional event defined as a process of influence (or control) between an individual (the leader) and his or her followers toward a common goal (Northouse, 2013). The organization of knowledge remains structurally hierarchical with a top down decision flow approach (see Figure 1). Yet, the heroic leadership paradigm is starting to be reexamined and questioned. In their study of the available leadership literatures on collective leadership, Corbett et al. (2018) demonstrated via a content analysis how leadership literatures, which had steadily increased since the start of the century, reached a peak in 2015, and have since been on a steady decline. In contrast, search terms for "collective leadership" have continued to

recently rise and present the efficacy traits of connectivism learning, including open communication, increased engagement, distributed knowledge, and collaboration (Corbett et al., 2018).

Henceforth, it is timely to apply the definition of connectivism to leadership to see how it can enrich and evolve it. "Essentially, connectivism views learning as a process of developing a learning network and making connections between ideas embedded throughout that network" (Dunaway, 2011, p. 676). A new way to think about leadership could be that leadership is a process of developing a knowledge network and making connections to create collective influence. This new way of leading – as a network-forming process, rather than through leader authority, power, control or hierarchy – could allow for a new way to define the leader-follower relationship altogether, in the same way that connectivism redefines the teacher-learner dynamic. Henceforth, the connectivity and power of the network could be used to influence apparent and legitimate power within an organization, significantly altering existing views on leadership theory (see Figure 2). This new form of leadership called "Connectivist Leadership" could be considered an influence creation process with and within networks and leverage technology as its basis of existence and survival.

From individual leaders to collective, connected team-based leadership models. Aside from reframing the social and technological context for leadership, connectivism offers another perspective to draw on for redefining leadership: it departs from the principality of the individual with the notion that today no individual is sufficient to have full control or full knowledge to lead others. Siemens (2005a, p. 5) notes that "realizing that complete knowledge cannot exist in the mind of one person requires a different approach to creating an overview of the situation. Diverse teams of varying viewpoints are a critical structure for completely exploring ideas." Siemens (2005b, p. 10) also argues that "knowledge does not only reside in the mind of an individual, knowledge resides in a distributed manner across a network." Based on this observation, Siemens discusses the changing responsibilities of teachers: "control being replaced by influence, so that instead of controlling a class, a teacher now influences or shapes a network" (Senior, 2010).

Similarly, "Connectivist Leadership" recognizes the limitations of individuals as leaders and the need to operate in more connected team-based leadership models with less hierarchical controlling structures.
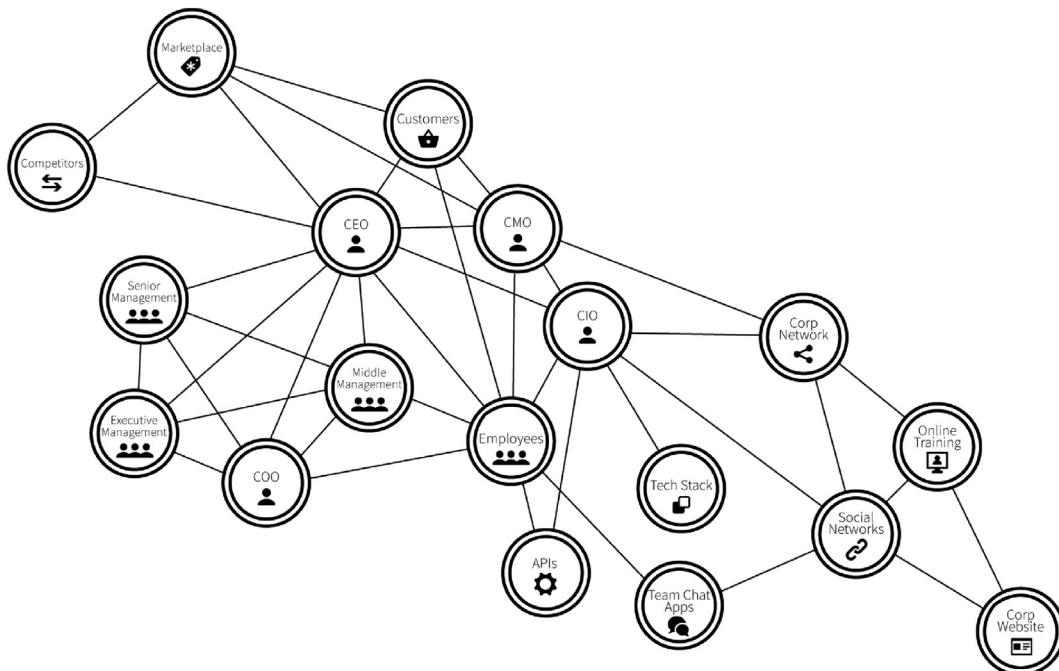

Figure 2. Connectivist leadership knowledge and decision flow.

Moses et al. (2018, p. 8) observe that "successful organizations can leverage team-based models and decision-making protocols rather than building traditional hierarchical business models." They add that these new connected team-based models require new leadership approaches that harness team-based decision-making rather than an individual approach. As Militello and Benham (2010, p. 620) highlight "what remains conspicuously absent from the leadership evaluation literature is a more inclusive diversity of voices that empowers multiple groups (not just individuals) to make meaning of leadership (beliefs) and to engage in collaborative leadership activities (action)."

Redefining personal learning environments. Tu et al. (2012) remark that "Siemens and Matheos (2010) suggested two trends in education; learners have the freedom to access, create, and recreate their learning content; and they have opportunities to interact outside of a learning system" (p. 13). Given the emergence of different teaching and learning models with technological affordances and new social environments, it is worth asking if a similar outlook might apply to leadership. Will greater learner freedom, autonomy, and independence result in a growing desire for leading oneself, rather than being a follower of others? Will the disappearance of teaching authority and control give rise to a more distributed form of leadership and the realization that everyone is a leader (Kouzes and Posner, 1995)? As a central element of the connectivism theory, learning networks could be examined as potential leadership networks too. It is interesting to recast the concept of Personal Learning Environments (PLEs) into People Leading Networks (PLEs), connecting people and resources for collective leadership, and improved collective outcomes.

In summary, a connectivist approach to leadership acknowledges the rapid changes in learning and leadership in the digital age, the value of a network-forming process, the principles of connected, distributed, and networked knowledge for learning and leadership, the distributed nature of influence, and the changing roles of teachers, learners, and leaders. The principles and ideas of connectivism applied to leadership provide a wide range of directions to reimagine leadership. Within this framework, individuals can self-direct their own leadership goals, manage the content and process by which they can form personal leadership networks, communicate and consult with others in the process of leading, and achieve a new form of collective and connected leadership which can be established as "Connectivist Leadership" for future research inquiry.

5. Conclusions

Although connectivism has received wide attention and debate, unlike other learning theories, it has lacked a lengthy history of testing, re-testing, and revision to arrive at a definitive framework for understanding how people learn differently and most effectively, in the digital world. Anchored in chaos theory, networking, complexity, and self-organization theories, connectivism was ground-breaking when it was first introduced over a decade ago in 2004. However, Siemens' original concept has not been updated and enhanced significantly at a theoretical level.

Given Moore's Law of computing which predicts the doubling of processing power every two years ("Moore's Law," n.d.) and the rapid advances in technology, it is pertinent to ask whether connectivism will remain applicable as a framework to explain and set guidelines for learning in an ever-changing environment. From an empirical perspective, connectivism needs more academic research to establish it firmly as a learning theory, especially as technology and learning continue to make rapid advances.

This literature review reveals that the nature of connectivism - its hybrid, interdisciplinary and somewhat controversial nature - invites many fascinating questions and calls for researchers who have an advanced understanding of, and passion for, technology and networking sciences. Research to understand the impact of connectivism and how technology in a connectivist framework is rewiring our brains is needed. Particularly pressing and of value, would be scientific research

leveraging the principles of connectivism itself – via networking technologies – to prove the theory of connectivism, and obtain verifiable evidence as to the phenomenon underlying the theory, its assumptions and beliefs and observable impact on learners, educators, and leaders.

Looking forward, research on the merits of artificial intelligence as it relates to human learning opens up many new unexplored areas and may validate connectivism's claim that learning can reside in both human and non-human appliances. From this perspective, the authors believe that connectivism holds the potential to be seen as a core competency of effective leadership in the twenty-first century and offer the following definition:

> *"Connectivist Leadership" redefines the leadership paradigm for the 21st century by recognizing that leadership is a dynamic, connected, and collective influence process, based on the principles of digital knowledge and interpersonal neural networks.*

> *Connectivist Leadership rejects the traditional follower-leader paradigm. As a collective and connected network-forming process, it challenges leading through a singular source of authority, power, control, or any form of hierarchy. Instead, it allows for the connectivity and power of the network to create legitimate influence within any kind of organization. No one person leads on their own, given how distributed and widespread knowledge has become. The network itself becomes the content provider and cognitive element capable of processing, guiding, filtering and evaluating new and relevant information for the collective to action.*

5.1. Recommendations for future research

Aside from validating connectivism as a learning theory, future research to apply connectivism to leadership would be of high value. Connectivism may offer a significant contribution to the evolution of conventional views of leadership from understanding the actions of individual leaders in determining the emergent dynamics of a connected collective. A better understanding of connectivism could be attained by identifying and quantifying the specific values, behaviors and technology tools that are associated with connectivist approaches to both learning and leadership.

Given the pervasive nature of social networking and a new generation of learners entering in the workplace, there is a need to re-conceptualize leadership by advancing its understanding from an individual influence on others to a collective, and connected shared process. The opportunity to study and establish a new concept of "Connectivist Leadership" can offer significant potential. By sharing how leadership is transforming, both theoretical and empirical contributions can be made towards a new genre of leadership that would show the significant advantages of how modern organizations could be organizing leadership approaches within team-based connected groups and leveraging new technologies that promote networked connections, cultural affinity, continual learning and shared situational networked leadership.

A study could aim to evaluate (1) if, and to what extent, leaders are shifting their views and understanding of leadership, from a process led primarily by an individual (Transformational, Leader-Member Exchange, etc.), to a system of connected, networked relationships, and (2) to what extent organizations, and leaders have altered their leadership approaches to ones that incorporate aspects of connectivist theory without necessarily having done so consciously. Such a study could further enhance both the understanding of this emerging form of leadership and of organizational learning, that is collective and connected by technology, by investigating how leaders assess their leadership experiences, attitudes, and behaviors and environmental cultures in the workplace, their working relationships with others and their usage of networking technology for leading in new distributed ways.

The exploration of this process for collective and connected leadership presents a significant opportunity to contribute to a vast body of work in leadership studies and extend the reinvention of leadership

dynamics in the future thanks to the foundation of learning theory, and emergence of new forms of knowledge.

Declarations

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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