

***Connectivism as a Driver to Improve Citizen Learning and engagement in  
Cognitive Cities: A Literature Review***

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**Abstract**

Society has changed as a result of new technologies of the digital age. Therefore, learning theories such as Behaviorism, Cognitivism, and Constructivism, no longer support learning actions in a technological era; since these theories were developed at a time when technology had no impact on learning at the level it does today and they were developed when knowledge grew slower. Additionally, population is always increasing and as citizens, learning does not occur only inside the classroom but also outside the classroom, in society, where we learn from each other in a connected world. In this context, the concept of smart cities and cognitive cities is becoming more significant. As a result, Connectivism, a new learning theory for the digital age has emerged, which is the link that connects new technologies with citizens. However, the use of Connectivism in cognitive cities is not an area in which a great deal of research exists. Thus, the purpose of this research is to analyze how Connectivism, a learning theory for the digital age, has been used in cognitive cities to improve citizen learning and engagement. The results showed several approaches on how Connectivism has been applied. Therefore, this body of research provides an insight into Connectivism and extends our understanding on how this learning theory is generating citizen learning and engagement in cognitive cities.

Keywords: Behaviorism, Cognitivism, and Constructivism, Connectivism, Cognitive Cities; Learning; Technology and Information

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## **Introduction**

Society has changed as a result of new technologies of the digital age. Furthermore, we live a knowledge explosion, what was considered to be powerful knowledge yesterday, is in doubt today, and may vanish tomorrow. AlDahdouh, Osório & Caires (2015) argue that "The time should be considered as a dimension of knowledge" (p. 12). This statement has encouraged Siemens (2004) & Arbesman (2012) to study the half-life of facts and they have concluded that the half-life of knowledge is shorter than ever.

Therefore, traditional learning theories such as Behaviorism, Cognitivism, and Constructivism, no longer support learning actions in a digital age; since these theories were developed at a time when technology had no impact on learning at the level it does today and they were developed when knowledge grew slower (Siemens, 2004). As a result, Connectivism, a new learning theory for the digital age has emerged, which is the link that connects new technologies with citizens. Connectivism, interprets learning happening outside the learners and calls it networked learning. In this context, the concept of smart and cognitive cities is becoming more significant.

However, the use of Connectivism in cognitive cities is not an area in which a great deal of research exists. Thus, the purpose of this research is to analyze how Connectivism, a learning theory for the digital age, has been used in cognitive cities to improve citizen learning and engagement. Considering that Connectivism is an area where not much research exists; this topic is fundamental.

## **Methodology**

This study employed a qualitative content analysis approach. During data analysis, the researchers looked for themes and patterns of connections (Zhang & Wildemuth, 2009); they immersed in data, so that, different themes emerged.

The study passed through three phases. The first phase was to look for keywords used in search engines and digital libraries. The keywords were: Behaviorism, Cognitivism, and Constructivism; Connectivism, Cognitive Cities; Learning; Technology and Information. The second phase was to filter by: publication date, descriptors, sources, publication type, location, and language. Finally, the third phase was to analyze the data where abstracts, discussions, results, and conclusions were the main target. So, finally, main results occurred.

## **Findings**

The following results show how the Connectivism learning theory is being used in cognitive cities.

Results showed that three broad learning theories have been most often used in educational environments: Behaviorism, cognitivism, and constructivism (See figure 1).

*Behaviorism* relates to learning as a change in behavior. It focuses on repeating a new behavioral pattern until it becomes automatic. It is a kind of teaching based on stimuli and responses, where the student does not appropriate knowledge and, the form of learning is usually by memorization. The learning success is measured by tests to accomplish each objective (Schuman, 1996). Some key representatives in the development of the behaviorist theory were Pavlov, Watson, Thorndike and Skinner.

According to Dembo (1994), *Cognitivism* is based on the thought process behind the behavior. Cognitivism suggests that learning is an internal process, where the learner cognitively processes the information. Changes in behavior are observed and used as indicators as to what is happening inside the learner's mind. A cognitive expert would analyze a task, break it down into smaller amounts and develop instruction that moves from simple to complex building on prior schema. The main representative of Cognitivism is Jean Piaget.

*Constructivism* is a philosophical position that knowledge arises through a process of active construction (Mascolo, 2005) Constructivism, a theory about knowledge and learning, describes both what knowing is and how one comes to know. (Jonasson, 1991) emphasizes that Constructivism describes knowledge not as truths to be transmitted or discovered, but as emergent, developmental, non-objective, and viable constructed explanations by humans engaged in meaning.

Constructivism assimilates learning as an active process where knowledge is built. Among the assumptions of Constructivism are: a) knowledge is built from experience, b) Learning is a personal interpretation of the world. c) Learning is an active process in which meaning is developed based on experience. d) Conceptual growth comes from the negotiation of meaning, the sharing of multiple perspectives, e) Learning should be situated in realistic settings, and f) testing should be integrated with a task, not a separate activity (Merrill, 1991, cited by Smorgansbord, 1997). In the same line, Social Constructivism was promoted by Vygotsky. He was a cognitivist, but he rejected the hypothesis made by Piaget that it was possible to separate learning from its social context. Some key representatives of the constructivist theory were David Ausubel and Vygotsky.

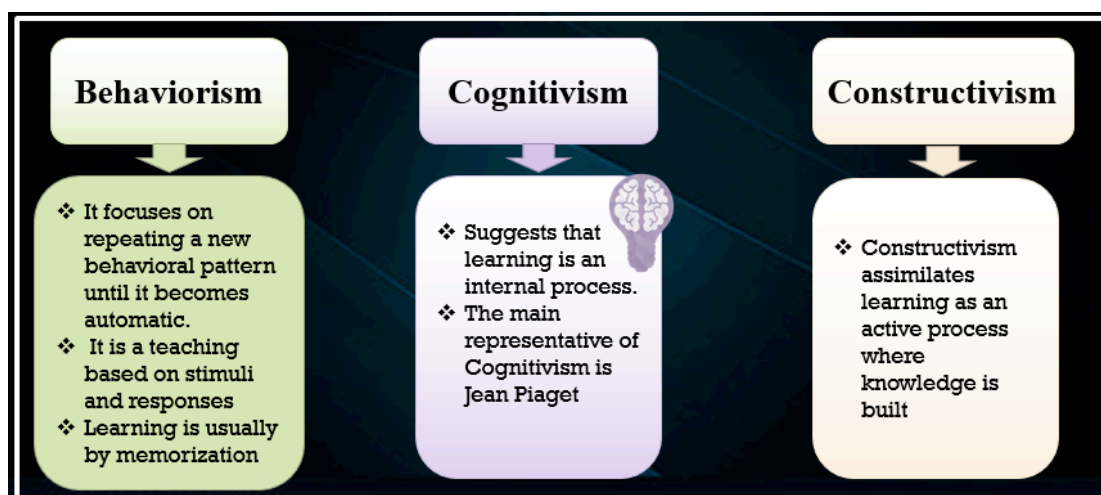


Figure 1: Learning Theories

However, according to Siemens (2004), learning theories, such as Behaviorism, Cognitivism, and Constructivism, have limitations because these theories were developed at a time when technology had no impact on learning at the level that it does today. In fact, these theories were developed when knowledge grew slower. These theories do not address learning that occurs outside of people (i.e. learning that is stored and manipulated by technology). They also fail to describe how learning happens within organizations. Due to those limitations, the Connectivism theory emerged. (See figure 2).

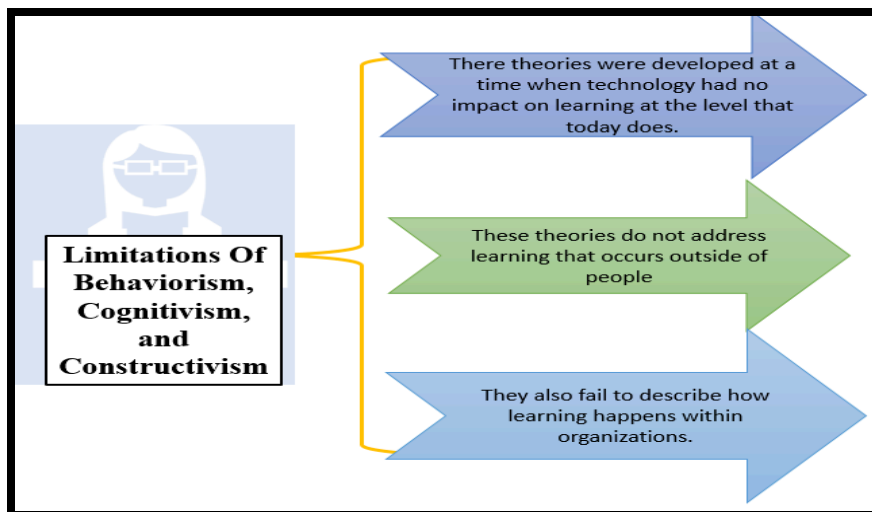


Figure 2: Limitations of Behaviorism, Cognitivism, and Constructivism

Gutiérrez (2012) claims that the concept of *Connectivism* is not new, this concept had already been raised with consistency in the work on socio-constructivism, in the article by Onrubia (2005, p.6), Processes of teaching and learning in virtual environments, in the theories of Conversation (Pask, 1975) and in general by Vygotsky -1978.

Connectivism is defined by (Siemens, 2004) as a theory of learning for the digital age, therefore, we can understand the emergence of this new trend in a social context characterized by the creation of economic value through networks of human intelligence to create knowledge. In this new scenario, technology plays a significant role in a society where the revolution of information technology has transformed the ways of doing business, the nature of services and products, the meaning of time at work, and learning processes (Fenwick, 2001).

Learning does not occur entirely under the control of the individual, learning can reside outside of ourselves, within an organization or a database. Siemens (2004, p.4) emphasizes the following aspects as the Principles of Connectivism:

- Learning and knowledge rests in diversity of opinions.*
- Learning is a process of connecting specialized nodes or information sources.*
- Learning may reside in non-human appliances.*
- Capacity to know more is more critical than what is currently known*
- Nurturing and maintaining connections is needed to facilitate continual learning.*
- Ability to see connections between fields, ideas, and concepts is a core skill.*

*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. (See figure 3).*

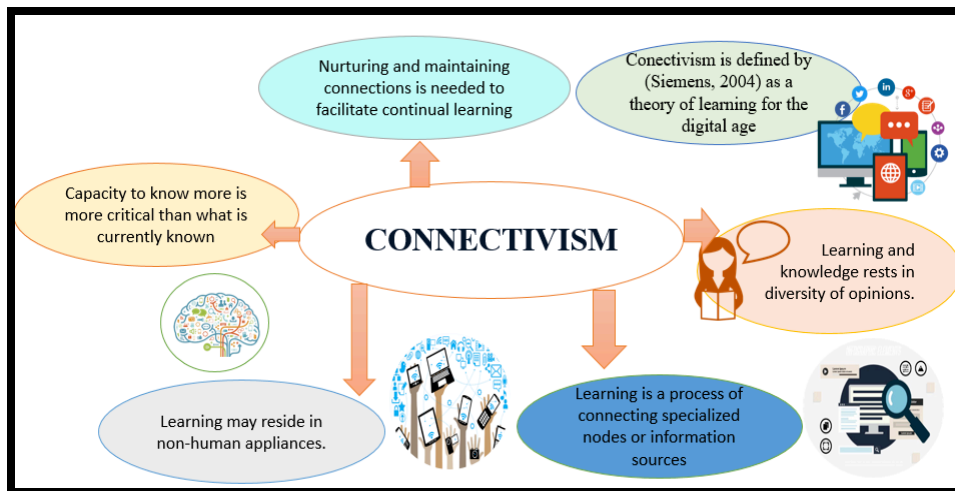


Figure 3: Connectivism

Thus, the Connectivism learning theory was created as a result of a belief that there was a need for a learning theory, which took into account the way in which society has changed as a result of new technologies for the digital age (Manzano et al, 2017). Additionally, population is increasing as well as citizens' needs and as citizens, learning does not occur only inside the classroom but also outside the classroom, in society, where we learn from each other in a connected world. In this context, the concept of smart and cognitive cities is becoming more significant.

*Smart city* is a concept for a modern city which is facing efficiency challenges. According to Machin & Solanas (2018), 54.5% of the world's population lived in urban areas in the year 2016. The United Nations estimates that, by 2030, this number will increase to over 60%, with one of every three people living in cities with at least half a million inhabitants and it is expected to reach over 70% by the year 2050 (United Nations, 2014). Such mega-cities will face enormous challenges regarding efficiency, sustainability and resiliency. With those challenges in mind, researchers proposed the idea of Smart City, as a way to fight against urbanization problems.

However, the new urban challenges cannot be addressed merely by ways of increased efficiency. These challenges relate to sustainability and resilience, requiring new and innovative approaches to urban governance. Such approaches will need to involve the "human factor", cognition, creativity along and the ability to learn so as to be able to deal with disruptive changes (resilience). This integration of the human factor within the smart city system creates cognitive cities.

*Cognitive cities* are smart cities, where the human factor is added. Finger & Portmann (2016) state that, cognitive cities are complex sociotechnical systems where it is not possible to address their challenges with technological developments and innovations only. The paradigm of cognitive city has emerged as a promising solution to the challenges that megacities of the future will have to face.

## Connectivism in Cognitive Cities

Learning takes place in different ways. The following are some scopes where the Connectivism learning theory constitutes a driver to improve citizen learning and engagement in cognitive cities: (See figure 4).

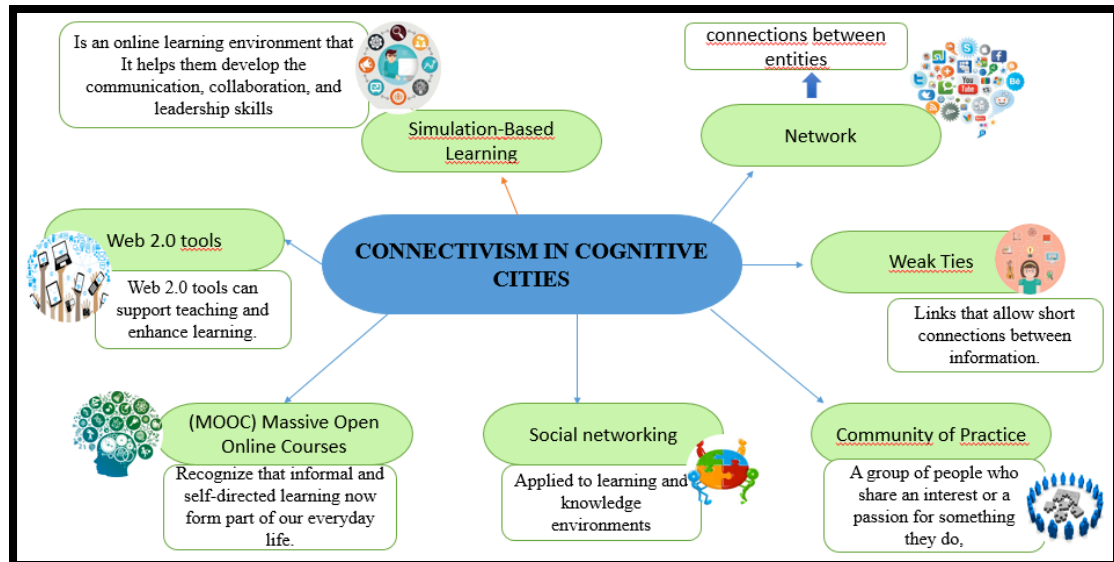


Figure 4. Connectivism in Cognitive Cities

### *Network*

It can be defined as connections between entities. Computer networks, power grids, and social networks function on the principle that people, groups, systems, nodes, and entities can be connected to create an integrated whole. (Siemens, 2004). Nodes can be fields, ideas, communities that specialize and gain recognition for their expertise, thus resulting in cross-pollination of learning communities.

Downes (2008) claimed that Connectivism is a form of knowledge based on ideas spread in a Network. According to Siemens (2004), the starting point of Connectivism is the person. Personal knowledge is incorporated from a network, which feeds into organizations and institutions, which in turn feed back into the network, and then continue to provide learning to the person. This cycle of knowledge development (personal - to network - to organization) allows learners to remain up-to-date in their field through the connections they make.

### *Weak Ties.*

According to Siemens (2004), weak ties are links that allow short connections between information. The small world networks are generally populated with people whose interests and knowledge are similar to each other. For instance, people finding a new job, often occurs through weak ties. Additionally, connections between unrelated ideas and fields can create new innovations.

## ***Community of Practice***

A community of practice is a group of people who share an interest or a passion for something they do, and they learn how to do it better as they interact regularly. Even though the phenomenon to which community of practice refers to is age – old, the term community of practice is of relatively recent coinage. Today, a growing number of people and organizations in several sectors are focusing on communities of practice as a key to improving their performance (Wenger, 2011). Three characteristics are essential: domain, the community, and the practice.

## ***Social networking***

Social networking theories and tools build new and effective e-learning practices. Pettenati & Cigognini (2007) argue that a social networking applied to learning and knowledge environments can lead to a reconceptualization of learning; in which formal, non-formal, and informal learning can be integrated as to build potentially lifelong learning activities to be experienced in personal learning settings.

## ***Massive Open Online Courses (MOOC)***

According to Kop & Fournier (2011). The propagation of Information and Communications Technology (ICT) in recent years has changed the educational landscape and helped in the creation of an overabundance of new opportunities for learning. Educators are changing their practice and are experimenting with open educational resources and cloud computing, such as Massive Open Online Courses (MOOC), recognizing that informal and self-directed learning now form part of our everyday life.

This new trend increases new opportunities and challenges for the self-directed learner. The learner might no longer rely on a trusted educator to support his or her learning work. The evolving technologies that are currently modelling the Internet and the Web provide us with access to information and the capacity to work and learn with others in a creative global collaboration outside the educational configurations that have been the standard for centuries (Downes, 2010; Fournier & Kop, 2010).

According to AlDahdouh & Osorio (2016), For-profit and non-profit companies have invested money and participated in the production of MOOCs. However, the integration and adoption of MOOCs in educational institutions around the world remains questionable. AlDahdouh & Osorio (2016) addressed the issues that higher education institutions should consider before adopting MOOC. Their findings showed eight interconnected and manageable MOOC issues: student assessment and language barrier, accreditation, business model, reputation, pedagogy, research ethics, and high dropout rate.

## ***Web 2.0 tools***

According to Siemens (2004) one of the most relevant theories, to come to prominence due to the rise of Web 2.0 is Connectivism. The use of Web 2.0 predominantly within Higher Education (HE) has become popular in recent years and consequently there is an increasing assortment of research concerning the way in

which Web 2.0 tools can support teaching and enhance learning. This trend has been led, particularly through the use of blogs to develop new forms of teaching, learning, pedagogy and learning theories under the connectivist theory.

Conole & Alevizou (2010) reviewed the use of Web 2.0 tools in Higher Education where they wanted to see evidence that Web 2.0 approaches are being used to foster and promote teaching scholarship and examples of teachers as learning communities. This study indicated that Web 2.0 tools offer features that have clear potential in an educational context to support a diversity of pedagogical approaches. Nevertheless, a number of challenges persist in terms of getting better implementation on these tools in education

### ***Simulation-Based Learning***

According to Lombardi (2007), Simulation-Based Learning, the Mekong e-Sim is an online learning environment. This online learning environment uses simulation and role-playing so that students get immersed in the complications of authentic decision making. It helps them develop the communication, collaboration, and leadership skills they will need to be successful practitioners in their fields.

Herrington & Oliver (2000) argued that, rich simulations of laboratories, clinics, schools, and other workplaces may expand the conservative internship experience in the future, if they offer learners immediate access to one another, to an extended family of mentors, and to the resources of the global network. As well, they highlighted that technological support for today's authentic learning environments commonly includes: a) High-speed Internet connectivity. b) Asynchronous and synchronous communication and social networking tools for the support of teamwork c) Intelligent tutoring systems, virtual laboratories, and feedback instruments that capture rich information about student performance and help students transfer their learning to new situations. And d) Mobile devices for accessing and inputting data during field-based research.

The following are some research and applications of Connectivism applied to solve citizens' problems:

### ***The Meta-application***

The Meta-application (meta-app) for cognitive cities presented by Kaltenrieder, Portmann, & D'onofrio, (2015) improves communication and thereby facilitates governance.

### ***The Internet of Things (IoT) and the Web of Things (WoT)***

As it is stated by D'Onofrio et al (2018), the Internet of Things (IoT) is used to create connections among smart things as well as between smart things and individuals. It is used in various applications for smart cities. Nonetheless, the IoT has several disadvantages, such as a lack of common standards, which are a requirement if many things as possible are to be connected. On the other side, the Web of Things (WoT), which is the IoT extended using Web standards, holds common standards and has many other advantages over the IoT. D'Onofrio et al (2018), states that when using



with the WoT, processes in cognitive cities, living standards can be improved. Thus, the WoT is appropriate for addressing the challenges faced by today's cities.

### ***Fuzzy Cognitive Maps***

According to D'Onofrio et al (2019), a primary task and an essential challenge is to process information in a city. Urban data are usually expressed in natural and imprecise language; however, they can contain relevant information that should be processed to progress the city. Fuzzy cognitive maps (FCMs) can be used to model interconnected and imprecise urban data.

### ***Synchronizing mind maps and fuzzy cognitive maps***

D'Onofrio (2017) presented a conceptual approach to improve knowledge management by synchronizing mind maps and fuzzy cognitive maps. When using mind maps, it is possible to take advantage of human creativity, while fuzzy cognitive maps can store and retrieve information expressed in natural language. By applying the concepts of cognitive computing, it makes it possible to gather and extract relevant information from a data pool. Therefore, this approach was intended to provide a framework that improves knowledge management.

### ***Fuzzy Analytical Hierarchy Process (FAHP)***

Kaltenrieder et al (2014) introduced a mobile application (app) as the first part of an interactive framework. The framework improved the interaction between cities and their citizens, introducing the Fuzzy Analytical Hierarchy Process (FAHP). This process acted as a potential information acquisition method to enhance existing citizen management activities for cognitive cities. Citizen management was improved by advanced visualization using Fuzzy Cognitive Maps (FCM). The proposed app took fuzziness into account in the constant interaction and continuous development of communication between cities or between their entities (e.g., the tax authority) and their citizens.

### ***Knowledge graphs and fuzzy cognitive maps***

Kaltenrieder et al (2015) gave an insight into cognitive computing for smart cities, resulting in cognitive cities. Cognitive cities and cognitive computing research with the underlying concepts of knowledge graphs and fuzzy cognitive maps were presented and supported by existing tools such as: IBM Watson and Google Now; and intended tools such as: meta-app. Their study illustrated FCM as a suitable instrument to represent information/knowledge in a city environment driven by human-technology interaction, enforcing the concept of cognitive cities.

### ***Digital Personal Assistant for Cognitive Cities***

Kaltenrieder et al (2016) presented an evaluation and initial testing of a meta-application (meta-app) for enhance communication and improve interaction (e.g., appointment scheduling) between stakeholders in cognitive cities. The results of the evaluation showed that the idea behind this meta-app has the potential to improve the living standards of citizens and to lead to a next step in the realization and maturity of

the meta-app. The meta-app helps citizens to effectively manage their time and organize their personal schedules and thus allows them to have more leisure time to take full advantage of it, and to ensure a good work-life balance to be more efficient and productive.

### ***A dynamic route planning***

Kaltenrieder (2019) presented a software prototype for dynamic route planning in the travel industry for cognitive cities. This prototype improves the travel experience for instance, sightseeing; by allowing additional flexibility to the user.

### ***Creative Reasoning***

Trillas (2019) introduced a first model of creative reasoning in a naïve way. A mathematical structure based on ordinary reasoning was elaborated to allow ‘creative jumps’ in reasoning, by presenting formal deduction. Aspects of natural language as well as of human thinking were mentioned to emphasize the importance of creativity in human life as well as in cities, considering the existing imprecision and uncertainty in natural language. This work could give the first hints of a possible mathematical model to enable creative reasoning in cognitive cities.

### ***Big Data***

Morabito (2015) discussed the transformation of the public service provision model due to big data, and in particular due to public engagement in the context of open government initiatives. The author deliberated 1) The use of a new sources of data, such as Crowdsourcing, Internet of Things, 2) public talent engagement, 3) institutionalize private–public partnerships and 4) searching for new models of value-for-money public provision, in addition to the challenges that big data present. Different aspects of this discussion were demonstrated through two case studies: Barcelona Smart City and Haiti’s emergency support during the 2010 earthquake disaster.

### **Implications and Limitations**

We agree that certainly, traditional theories present limitations because they were developed at a time when technology had not much impact on learning at the level it has today. Therefore, Connectivism (Siemens, 2004) appears as the learning theory for "the digital age"; since, technology today is a powerful instrument that revolutionizes information and transforms the world. The current communication and cultural environment has as its main component information and communication technologies. Additionally, new generation students were born in a digital environment and the behaviors associated with it are opposed to those expected in a traditional education.

Several options are presented in this study, where citizens can interact and get connected to information networks that allow people to learn, build, and share knowledge; such as communities of practice, Web 2.0, networks and so on. On the World Wide Web, Connectivism promises to establish learning spaces through so-called Massive Open Online Courses (MOOC), blogs, Webquests, and many others.

The variety of options makes learning and teaching innovative with the use of different sources, tools, methods and ways to share information among people interested in learning. However, in order to implement them in an appropriate way, great challenges must be analyzed, such as access to internet connectivity, virtual laboratories, and mobile devices, among others.

Additionally, applications such as Meta-applications, the Internet of Things (IoT) - the Web of Things (WoT), fuzzy cognitive maps. - synchronizing mind maps and fuzzy cognitive maps, Fuzzy Analytical Hierarchy Process (FAHP), digital personal assistant for cognitive cities, a dynamic route planning, creative reasoning, and big data are being developed to solve city problems and citizens' needs.

Some critics to Connectivism also appear. This is the case of Clarà & Barberà (2014) who examined the theoretical postulates of Connectivism and identified three important psychological and epistemological problems: 1) The lack of a solution to the learning paradox, 2) The under conceptualization of interaction, and 3) The inability to explain concept development. Some of the theoretical deficiencies may explain certain learning problems experienced by participants in MOOCs. The authors concluded that, although MOOCs are a worthwhile experience and ought to be continued, Connectivism as a learning theory has significant theoretical problems and should be deeply revised if it is to explain and foster learning in such environments.

Without doubt, Connectivism, a learning theory for the digital age, is a topic that needs the attention of investigators, because it is a new, updated, important and relevant topic.

Developed countries are working towards needed changes in city management, where Connectivism is the base of Cognitive cities. It assumes that knowledge is built through the experiences and perceptions of diverse people. Hence, the design of a cognitive learning process in a city is crucial (D'Onofrio et al, 2019). In this sense, a broad of opportunities are emerging in an unconscious way in non-developed countries too such as Ecuador where one of the research lines is dedicated to development, Innovation and Knowledge Transfer in ICT. Therefore, educators, investigators, and policy makers, should consider this research line to develop their plans in a cognitive cities arena.

Future research will focus on methodologies used for learning in Connectivism.

## **Conclusion**

In a digital age education and cognitive cities need Connectivism to create better learning environments and a better and more practical citizen lifestyle, searching for efficiency, order, and progress that our society needs.

In Connectivism the two general ways to acquire knowledge include: pulling knowledge from personal experience and learning from others. In this way, Connectivism supports learning from each other by making connections. Additionally, in the Connectivism theory, learning is a process of connecting specialized nodes or information sources where learning can reside in human and non-human appliances. Consequently, when talking about connections, the sources

are not only technological sources, but they can also be experiences, facts, ideas, and communicative learning environments, among others.

Thus, because of the several applications of Connectivism, mentioned in this study, where information / knowledge is shared in the society or city environment driven by human-technology interaction enforcing the concept of cognitive cities, we conclude that the Connectivism learning theory constitutes a driver to improve citizen learning in cognitive cities.

## References

- Aldahdouh, A. A., Osório, A. J., & Caires, S. (2015). Understanding knowledge network, learning and connectivism. *International Journal of Instructional Technology and Distance Learning*, 12(10), 3–21.
- AlDahdouh, A., & Osorio, A. (2016). Planning to Design MOOC? Think First!. *The online journal of distance education and E-Learning*, 4(2).
- Arbesman, S. (2012). *The half-life of facts: Why everything we know has an expiration date*. New York: Penguin.
- Clarà, M., & Barberà, E. (2014). Three problems with the connectivist conception of learning. *Journal of Computer Assisted Learning*, 30(3), 197-206.
- Conole, G., & Alevizou, P. (2010). A literature review of the use of Web 2.0 tools in Higher Education. A report commissioned by the Higher Education Academy.
- Dembo, M. H. (1994). (5th ed.). White Plains, NY: Longman Publishing Group.
- Downes, S. (2008). Places to go: Connectivism & connective knowledge. *Innovate: Journal of Online Education*, 5(1), 6.
- Downes, S. (2010). The role of the educator. *Huffingdon Post*
- D’Onofrio, S., Papageorgiou, E., & Portmann, E. (2019). Using Fuzzy Cognitive Maps to Arouse Learning Processes in Cities. In *Designing Cognitive Cities* (pp. 107-130). Springer, Cham.
- D’Onofrio, S., Franzelli, S., & Portmann, E. (2018). Advancing Cognitive Cities with the Web of Things. In *New Advances in the Internet of Things* (pp. 75-91). Springer, Cham.
- D’Onofrio, S., Müller, S. M., Papageorgiou, E. I., & Portmann, E. (2018, July). Fuzzy Reasoning in Cognitive Cities: An Exploratory Work on Fuzzy Analogical Reasoning Using Fuzzy Cognitive Maps. In *2018 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)* (pp. 1-8). IEEE.
- D’Onofrio, S., Portmann, E., Kaltenrieder, P., & Myrach, T. (2017). Enhanced knowledge management by synchronizing mind maps and fuzzy cognitive maps. In *The of Application Fuzzy Logic for Managerial Decision Making Processes* (pp. 15-23). Springer, Cham.
- Fenwick, T. (2001). *Experiential learning: A theoretical critique from five perspectives*. Columbus: Ohio State University.
- Finger, M., & Portmann, E. (2016). What are cognitive cities? In *Towards Cognitive Cities* (pp. 1-11). Springer, Cham.

Fournier, H., & Kop, R. (2010). Researching the design and development of a Personal Learning Environment. Paper presented at the PLE Conference, Barcelona, Spain.

Gutiérrez, L. (2012). Conectivismo como teoría de aprendizaje: conceptos, ideas, y posibles limitaciones. *Educación y Tecnología*, (1), 111-122.

Habitat, U. N. (2013). *State of the world's cities 2012/2013: Prosperity of cities*. Routledge.

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*, 48(3), 23–48

Jonasson, D. H. (1991). *Thinking technology: Toward a constructivist design model*.

Kaltenrieder, P., Parra, J., Krebs, T., Zurlinden, N., Portmann, E., & Myrach, T. (2019). A dynamic route planning prototype for cognitive cities. In *Designing Cognitive Cities* (pp. 235-257). Springer, Cham.

Kaltenrieder, P., Papageorgiou, E., & Portmann, E. (2016). Digital personal assistant for cognitive cities: a paper prototype. In *Towards Cognitive Cities* (pp. 101-121). Springer, Cham.

Kaltenrieder, P., Portmann, E., & D'onofrio, S. (2015, April). Enhancing multidirectional communication for cognitive cities. In *2015 Second International Conference on eDemocracy & eGovernment (ICEDEG)* (pp. 38-43). IEEE.

Kaltenrieder, P., Portmann, E., & Myrach, T. (2015, August). Fuzzy knowledge representation in cognitive cities. In *2015 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)* (pp. 1-8). IEEE.

Kaltenrieder, P., Portmann, E., D'Onofrio, S., & Finger, M. (2014, October). Applying the fuzzy analytical hierarchy process in cognitive cities. In *Proceedings of the 8th international conference on theory and practice of electronic governance* (pp. 259-262). ACM.

Lombardi, M. M. (2007). Authentic learning for the 21st century: An overview. *Educause learning initiative*, 1(2007), 1-12.

Kop, R., & Fournier, H. (2011). New dimensions to self-directed learning in an open networked learning environment. *International Journal of Self-Directed Learning*, 7(2), 1-18.

Machin, J., & Solanas, A. (2018). A Review on the Meaning of Cognitive Cities. In *2018 9th International Conference on Information, Intelligence, Systems and Applications (IISA)* (pp. 1-5). IEEE.

Manzano-León, A., Aguilera-Ruiz, C., Lozano-Segura, M. C., Yanicelli, C. C., & Aguilar-Parra, J. M. (2017). Conectivismo y dislexia. *Revista INFAD de Psicología. International Journal of Developmental and Educational Psychology.*, 4(1), 253-260.

Mascolo, M. F. (2005). Change processes in development: The concept of coactive scaffolding. *New Ideas in Psychology*, 23(3), 185-196.

Morabito, V. (2015). Big data and analytics. Strategic and organizational impacts.

Onrubia, J. (2005). Aprender y enseñar en entornos virtuales: actividad conjunta, ayuda pedagógica y construcción del conocimiento. *Revista de educación a distancia.*

Pask, G. (1975). Conversation, cognition and learning.

Pettenati, M. C., & Cigognini, M. E. (2007). Social networking theories and tools to support connectivist learning activities. *International Journal of Web-Based Learning and Teaching Technologies (IJWLTT)*, 2(3), 42-60

Schuman, L. (1996). Perspectives on instruction. [On-line]. Available: <http://edweb.sdsu.edu/courses/edtec540/Perspectives/Perspectives.html>

Siemens, G. (2004). Connectivism. A Learning Theory for the Digital Age. ElearnSpace.org.

Smorgansbord, A. (1997). Constructivism and instructional design. línea: <http://hagar.up.ac.za/catts/learner/smorgan/cons.html> Consultado, 12.

Trillas, E., D'Onofrio, S., & Portmann, E. (2019). An exploration of creative reasoning. In *Designing Cognitive Cities* (pp. 85-106). Springer, Cham.

United Nations. (2014). World urbanization prospects. *World Urbanization Prospects: Highlights*, 28.

Wenger, E. (2011). Communities of practice: A brief introduction.

Zhang, Y., & Wildemuth, B. M. (2009). Qualitative analysis of content. *Applications of Social Research Methods to Questions in Information and Library Science*, 308–319.

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