



Origins of Connectivism as New Learning Paradigm in the Digital Era*

Roberto Sánchez-Cabrero 


Universidad Alfonso X El sabio, Madrid, España

Óscar Costa-Román 

Universidad Isabel I la católica, Castilla, España

Lidia Mañoso-Pacheco 

Universidad de Antonio Nebrija, Madrid, España

Miguel Novillo-López 

Universidad Nacional de Educación a Distancia, Madrid, España

Francisco Pericacho-Gómez 

Universidad de Antonio Nebrija, Madrid, España

Open Access:

ISSN: 0124-2121
E-ISSN: 2665-2420

Editor:

Patricia Martínez Barrios
Universidad Simón Bolívar

Corresponding author:

Roberto Sánchez
robsan9@gmail.com

Received: 10-18-2018

Accepted: 11-20-2018

Published: 02-01-2019

DOI:

<http://dx.10.17081/eduhum.21.36.3265>

Copyright© 2019 Educación y Humanismo

Abstract

Objective: To review the theoretical roots of Connectivism in the main historical theories about knowledge acquisition and learning, as it is the most useful educational paradigm to understand learning in the digital era and e-learning processes. **Method:** Through an exhaustive compilation of pertinent original sources, selected based on relevance and meaning within each theoretical stream, connectivism is introduced as an evolution with respect to previous schools and not as a theoretical revolution in the pedagogical field. Psychoanalysis and the School of Gestalt Psychology, on their part, are regarded in this research as the earliest backgrounds, and Instructionism, Constructivism, the Chaos Theory, Neuroscience, the Network Theory and the Theory of Complex Adaptive Systems are also introduced in this paper as direct predecessors. This paper continues with the analysis of the influences received by the different contemporary and current theoretical schools, such as the Conversation Theory, the Actor-Network Theory, Network Learning, E-Learning 2.0., Microlearning, Nano-learning, University 2.0., Curriculum 2.0., Pedagogy 2.0. and Navigationism to complete the theoretical basis on which Connectivism is based. **Conclusion and Discussion:** The theoretical connections of Connectivism with the exposed theories are confirmed, and increased relevance of this paradigm in the educational field is expected due to its adaptation to the current social reality.

Keywords: Connectivism, Educational paradigms, Social networks, New technologies, E-learning.

How to cite this article (APA): Sánchez-Cabrero, R., Costa-Román, O., Mañoso-Pacheco, L., Novillo-López, M & Pericacho-Gómez, F. (2019). Orígenes del conectivismo como nuevo paradigma del aprendizaje en la era digital [Origins of Connectivism as New Learning Paradigm in the Digital Era]. *Educación y Humanismo*, 21(36), 113-136. DOI: <http://dx.10.17081/eduhum.21.36.3265>

*Article translated to English

Introduction

Learning in the digital era is characterized by a constant connection of the learner with the environment. This environment is not only based on the physical or theoretical proximity to the learner but also on the possibility of access by means of the different virtual networks, such as the Internet or digital social media (Twitter, Facebook, etc.) (Nobles, Londoño, Martínez, Ramos, Santa & Cotes, 2016; Maldonado, 2017).

The rupture of the barrier of distance in education was a collateral effect of this constant connection. Education through the connection to virtual environments can no longer be called "distance education"; it has evolved into a qualitatively different modality called electronic learning or e-learning (remote knowledge acquisition, through electronic channels, mainly the Internet). The main differences between traditional distance education and e-learning, according to Rivera, Alonso & Sancho (2017), are as follows:

- E-learning is only possible if there is a strong presence of ICTs (Information and Communication Technologies), especially the Internet.
- Educational communities are created between teachers and students, just students, or just teachers.
- Students are autonomous.
- It is based on asynchronous education.
- Distance between the teacher and students is not always a factor.

Classic and current learning models fail when trying to explain this learning, given that a great part of it is not aimed at any specific purpose, nor does it depend directly on the learner's will and voluntariness, but it derives directly from the merger of learners with their environment and the adoption of their principles, lifestyles, attitudes, etc. (Fuentes, 2017).

Connectivism is the only current theoretical approach capable of offering an adequate understanding of this type of learning; the remaining theoretical paradigms have a limited scope to show the influence of the interconnected digital world on the learner, given that, for these paradigms, learning is always individual and voluntary, qualities that are contrary to current learning in the digital era (Islas & Delgadillo, 2016).

Reflecting on the contribution of the main theoreticians of Connectivism, a theoretical foundation can be found on which to base some principles and an approach to understand it. Talking about an approach instead of a theory on knowledge acquisition is not a trivial act, as this can avoid most current criticism to Connectivism, including those made by Downes, one of the founders and main promoters of this theoretical approach to education (Downes, 2008; Forster, 2008; Zapata-Ros, 2015).

This connectivist perspective emphasizes the pragmatic utility of connectivist

statements. Connectivism serves to interpret and understand the processes associated with learning and knowledge acquisition in today's world, especially in relation to the technological evolution of social media and multiform environments of learning, mediation, and recreation of learning situations linked to technologies through e-learning. Therefore, connectivist principles should not be used to explain all forms of learning and knowledge acquisition, as these involve finding gaps covered by previous theories, complemented by Connectivism for adaptation to the technological digital world (Downes, 2016; Flórez, Pérez & Amaya, 2017).

In its attempt to understand how knowledge is acquired and how learning is produced, Connectivism defines the human mind as a network that adapts to the environment. Following this line of thought, learning would be understood as the network formation process through connections between different nodes, with knowledge residing in such networks. The learners' role is active and creative, as they have the need to constantly adapt to their environment through the creation of new connections, the recognition of patterns, and learning through decision-making experience (Siemens 2006, Siemens & Conole, 2011).

An essential concept in Connectivism is the idea of knowledge as voluble, unstable, uncontrollable and in continuous expansion, which implies an escape from the person's total control, being able to reside in external networks (communities, digital devices, etc.) while being in constant change. Therefore, Connectivism is not only a conception of knowledge and individual human learning but also an approach to understand the collective mentality of a network of people, a community, or a society based on one principle, the generation of ecologies of networks in constant change and development (Aguilar & Mosquera, 2015).

It is easy to recognize the similarities between the conception of human mind and knowledge according to Connectivism with the network of networks (the Internet) and with the emergence and rapid expansion of digital social media such as Twitter, Facebook, etc. This is only logical, given that we are dealing with human creations, the success of which is measured based on their adequacy for the satisfaction of the human need of creation and use of social media to adapt to the environment, there being a great secondary benefit to its use aimed at social development, including non-formal social learning. This is the main importance of Connectivism, as it is undoubtedly the most robust theoretical psycho-pedagogical approach with the best conditions to describe and explain today's world, where social and digital environments intertwine. This gives rise to the creation of new forms of knowledge acquisition and learning, for which the previous theories turn out to be insufficient and incomplete, starting with the new characteristics of knowledge acquisition in this digital era, which make it voluble, disorganized, horizontal, democratic, and above all, in constant and exponential expansion.

The objective of this theoretical review is to show how Connectivism has not emerged independently from the other theoretical schools but as the product of all of them adapted to the digital era. Connectivism is then based on a series of theoretical backgrounds that are born in psychology and pedagogy and found continuity in Connectivism, as will be shown throughout this review.

Methodology

This review of the origins of Connectivism in previous theories on learning and knowledge acquisition is based on the need of some members of the current scientific community in the field of pedagogy and history of education to reflect a plausible timeline showing the evolution of this field to this day and justify Connectivism as a current theoretical approach for pragmatic reasons.

Various experts in the field of education, pedagogy, psychology, history, and new technologies applied to education have tried to reflect the theoretical roots of the postulates of Connectivism, so an exhaustive search of pertinent original sources was conducted through different scientific databases online (Google Scholar, Psycnet, Eric, etc.) and the best and most recognized journals in the different theoretical fields according to Web of Science and Scopus. The document selection criterion applied for the analysis and the references selected was established based on the international relevance of each work and author within each paradigm and theoretical school, and the citation of such as key, influential, or paradigmatic for the understanding of the theoretical basis of each theoretical stream.

Finally, the historical relevance of the different references found was used to carry out this review, which is the product of the intense and dedicated work by each of the authors, each with different profiles and professional experiences.

Development and Discussion: Main theoretical references for Connectivism.

1.1. Earliest backgrounds

The earliest background of Connectivism can be found in the psychotherapeutic practice of Psychoanalysis (Freud, 1900, cited in Freud, 1984). Connectivism shares some curious similarities with this controversial psychological school, thus a mild parallelism can be made between both. Both Psychoanalysis and Connectivism share the following main characteristics:

- Both schools mostly arise from the creation of a single author: Freud (1900, cited in Freud, 1984) and Siemens (2004), even though they both received enriching contributions from different authors later on.
- As is the case with the emergence of new theoretical trends in most scientific fields, both theoretical schools emerge with the intention of addressing what other contemporary scientific theories cannot explain: human behavior. The main difference is that Freud seeks to understand human motivations mainly through the idea of the unconscious, while Siemens seeks to complete the gaps and inadequacies left by classical learning theories, especially in relation to a rapid and broad increase of knowledge, considered by Siemens as his main Achilles' heel (Siemens & Conole, 2011).
- Both schools have received strong criticism as scientific theories, better to be considered as perspectives—a therapeutic perspective in the case of

Psychoanalysis, and a pedagogical perspective in the case of Connectivism.

- Given that both schools spread quickly and generated a strong influence, both within their field and others, they were a great focus of scientific interest in their time.
- Finally, the main similarity between both derives from the great importance given to the human mental functioning in the form of a network. On the one hand, in Psychoanalysis, Free Association is a key therapeutic method (Freud & Breuer, 1895, cited in [Schutt, 1995](#)). On the other hand, Connectivism defines learning as the process of connecting nodes or sources of information. Therefore, it can be concluded that both schools consider a very similar functioning of the human mind when reasoning or learning in the form of a network, and when connections are made between ideas.

Another early background of Connectivism can be found in the School of Gestalt Psychology. The theoreticians of this school consider learning to be a development process of new ideas or a modification of the old ones ([Wertheimer & Riezler, 1944](#)). To do so, learners must have an active role in their learning, as they learn intentionally, exploring their environment and circumstances, and using their creativity. This idea intertwines with the connectivist need of the learning network to “reform and adapt.” Siemens believes that learners form networks of knowledge that they adapt to their current needs and subsequently modify based on their changing circumstances ([Siemens & Conole, 2011](#)).

Just like in the School of Gestalt Psychology, Connectivism also considers a global vision of reality with a purely pragmatic purpose. In both theoretical schools, knowledge is contingent on the global vision it generates, so it is less important than the views in which it merges, and its meaning is mutable based on the circumstances. Learners form their own reality using the elements (knowledge) that they dispose of; therefore, the active and creative attitude of the learner is key to generate learning, which is also completely personal and unique from one learner to another.

Additionally, it is worth mentioning that some of the main Gestalt laws (similarity, proximity, symmetry and order, etc.) are principles that reflect the particular way in which the human mind makes connections and associations ([Rock & Palmer, 1990](#)). These laws are also used by Connectivism to reflect how a network of knowledge is formed and modified at each time and by each learner ([Siemens & Conole, 2011](#)).

1.2. Backgrounds in pedagogical and psychological sciences

The continuous development of knowledge in psychological and pedagogical sciences has entailed a great source of references for Connectivism. Many highly relevant authors have served as inspiration for some of the most important connectivist authors (Siemens, Downes, etc.). Authors such as Bruner, Ausubel, Piaget, Bandura, Gagné, etc. and scientific trends such as Network Theory, Neuroscience, Instructionism, Chaos Theory, among others, have set the grounds for the elaboration of the main connectivist axioms.

Given the traditional juxtaposition of Instructionism and Constructivism in education, Connectivism is, without a doubt, much closer to the latter ([Duffy & Jonassen, 2013](#)).

However, this does not imply that some of the ideas of Instructionism had not served as references. Considering Instructionism, as defined by Papert (1995), as the “expression of believing that the perfectionism of instruction leads to better learning” (p. 151), it can be observed how Connectivism agrees with this theoretical trend that it is the practice and perfectionism what leads to a deeper and more complex knowledge in the learner, even though for Connectivism, this process does not consist on the perfection of the instruction, but on the improvement of the learners’ decision making based on the improvement of their network of knowledge (Rodríguez, 2016). The network richness would lead to a more complex view and a deepening more focused on the learner’s interests.

With regard to Constructivism, this trend is identifiable with the third metaphor of learning according to Mayer (Mayer, 1992, cited by Zapata-Ros, 2015), as observed in Table 1:

Table 1.

The three metaphors of learning			
Learning as	Teaching	Instructional focus	Results
Acquisition of responses	Provide feedback	Curriculum-centered (Adequate behavior)	Quantitative (Strength of associations)
Acquisition of knowledge	Transmit information	Curriculum-centered (Adequate information)	Quantitative (Amount of information)
Construction of meaning	Guide cognitive processing	Student-centered (Meaningful processing)	Qualitative (Structure of knowledge)

Source: Mayer, 1992, cited in Zapata-Ros (2015).

Within the constructivist perspective of the construction of meaning in learning, it is worth noting the diversity of theoretical approaches from different authors that have also served as basis for the connectivist theories.

The first constructivist theoretical approach that serves as background for Connectivism is the School of Gestalt Psychology, with Von Wertheimer and Köhler as promoters, which was already discussed above.

The main promoter of Constructivism in education, Piaget, introduced the importance of interaction with the social environment in his development of the Constructivist Theory of Learning. According to Piaget (1954), learning is built from the maturity and experience of learners in their social and physical environment, which broaden and modify mental structures into more complex ones.

Gagné (1971) is another author that serves as inspiration for Connectivism, by considering that there are internal and external conditioning factors that regulate the learning process. In this sense, he shared the connectivist idea of ecology and adaptation to the social environment. Internal conditioning factors work as storage for the acquisition of capacities that are pre-requirements for learning; external conditioning factors refer to the context where learning is facilitated.

Another relevant author in Constructivism, [Bruner \(1966\)](#), introduced the concept of Discovery Learning, which implies accepting the idea that non-intentional learning and the emergence of challenges can modify the learner's interests and way of solving problems. [Siemens \(2004\)](#) developed this idea as the complete definition of a problem through the combination of different points of view of the agents implied by means of their individual creativity, who end up discovering a deeper view of the problem based on the casual combination of their particular interests. On the other hand, [Bruner \(2001\)](#) considered student-teacher active dialogue as a key aspect of learning, which implies the creation of a knowledge-generating external learning network, as affirmed by connectivist ideas.

Vygotsky was also a strong connectivist inspiration. In 1932, he developed the idea of competence and considers social factors as external triggers of learning in the form of an external network of knowledge. However, his clearest inspiration may be the idea of the Zone of Proximal Development, an idea that he defines as:

The distance between the actual development level of a child as determined by independent problem solving and the highest level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers ([Vygotsky, 1932](#), cited in [Wertsch, 1988](#); p. 84).

This idea of [Vygotsky \(1932\)](#) with regard to the Zone of Proximal Development is directly related to the functioning of a connectivist network of knowledge and agrees with the connectivist principle that "the ability to increase knowledge is more important than what is already known" ([Siemens, 2006](#); p. 31).

Finally, [Ausubel \(1964\)](#) conceived learning as a process of attribution of meaning. New knowledge must be connected with previous knowledge; this way, knowledge is transformed, becoming more complex and deeper. In this process, learners also gain capacity of adaptation to new situations, because they have a more solid knowledge, where more elemental knowledge sustains more complex ones in a hierarchical (scaffolding) structure similar to the connectivist functioning of a network.

The metaphor of learning as Construction of Meaning inherent to Constructivism meant the natural evolution of Cognitivism towards a student-focused curriculum ([Abrio & Bermudez, 2017](#)). From this perspective, students have an active and central role in their own learning, as they build and structure their own learning through the construction of meaning to the knowledge they acquire. The constructivist perspective of cognitivism has prevailed from the 1980s until today in the educational scientific sphere, and represents various changes in the educational configuration of learning in schools today, serving as reference for new educational methodologies that are currently implemented, such as project-based education, working corners, etc. ([Cathalifaud, 2014](#)).

Connectivism shares a great part of this global vision of learners in Constructivism, as a central role is also given to learners, assigning an active role to them in the election of content and the way to structure them with a single and proper meaning. However, they differ in a substantial aspect: Connectivism rejects the idea of the constant building of meanings. As affirmed by [Siemens \(2006\)](#) "we are not always building (which implies a cognitive load), but we are constantly connecting (p. 27)." Thus, according to connectivist postulates, learners are not always building, which implies an attempt to organize the chaos of knowledge within the reach of the learner, but, occasionally, they are simply enriched by navigating this chaos without the need to organize, or even

disorganizing the organized, that is, meaningfully deconstructing the constructed. For example, it is easy to understand this navigation of chaos without the constant construction of meanings in the learner when thinking about any person navigating the Internet aimlessly, simply guided by their momentary interest and curiosity.

This Connectivism's criticism of Constructivism introduces another psycho-pedagogical background of Connectivism: Chaos Theory applied to education. According to Chaos Theory, social sciences are unfinished and embrace distorted and chaotic phenomena that generate disorder from order, and vice-versa (Castells, 1999). Therefore, education, as a social science, should be based on such perspective, given that the idea of order as the carrier of the scientific truth is an outdated idea, already disproven, and not applicable to the social sciences, which are always in constant construction and deconstruction. As affirmed by Colom (2005):

The epistemology inherent to the human and social sciences, and, therefore, the discourse on education, after modernity, must conjugate complexity and disorder. In other words, it must dispense with simplicity (the analytical paranoia of modernity), and of the order as carrier of certainties, which continue to be qualities inherent to the science of the 19th century (p. 1327).

From the cognitive point of view, creativity is regarded as the chaotic engine of intelligence (Colom, 2005), which opens the doors to the disorder generated by the knowledge acquired by the learner and leads to new and complex learning achievements that can be re-ordered at a superior level, and so on, indefinitely.

It is easy to see the inspiration of Connectivism in these principles of Chaos Theory. Connectivism, just as Chaos Theory, does not consider all learning to be directed, generator of cognitive order, and intentional. They also agree that the constant fluctuation of knowledge makes the trend perishable and ends up being the germ of the new. However, the scope of Chaos Theory to define the learner's learning acquisition is more limited, given that it does not consider connection nodes as supporting points when defining each learner's learning, so there would be no foundation on which to base decision making (Arenas, 2018). According to Chaos Theory, there is no clear structure guiding the learner; therefore, everything could be the same or different. In Connectivism, this network of knowledge formed by nodes is what structures learning and knowledge, and serves as a non-deterministic basis for future learning with a changing personality, but concrete and personal, which is not determined from the perspective of Chaos Theory.

Additionally, current scientific advances in Neuroscience have strongly supported connectivist theories. Discoveries in cognitive neuroscience in relation to the functioning of mirror neurons discovered by Rizzolatti, Fadiga, Matelli, Bettinardi, Paulesu, Perani & Fazio (1996) confirm the connectivist idea that knowledge can materialize in the human mind without the mediation of symbolic aspects and, therefore, without the constant creation of meanings.

Initially, mirror neurons were considered executors of imitation properties in the human being, but it has been discovered that they do much more than that. According to many studies, this neural system, particularly present in frontal parietal areas of the cerebral cortex, allows humans to feel sensations, emotions, and even actions that are perceived in

others as their own. These findings suggest that many human systems may be equipped with neural reflex mechanisms, both for the integration and differentiation of perceptive and motor aspects of the actions carried out by ourselves and by others (Mukamel, Ekstrom, Kaplan, Iacoboni & Fried, 2010). The nexuses with Connectivism are clear: the idea that knowledge is distributed, not only in one human being, but through our inter-species empathy, which can also reside in non-human devices (a movie, a song, an Internet browser, etc.) is reinforced, as well as the idea that the human being is constantly connected, beyond its cognitive analysis, expanding its knowledge in the form of a network.

The main reference to associate Connectivism with other social or socio-psychological sciences can be found in Network Theory, which is based on the School of Gestalt Psychology and was initially driven by the work of the psychology teams of Lewin (1938) and the sociometrical studies conducted by Moreno (1962). The theoreticians of this proposal seek to analyze the group functioning of a network of people based on the assumption that what people feel, think, and do as a group originates and manifests in the situational relationship guidelines they do and do not have in their individual attributes (Lozares, 2005). Therefore, a network would have its own entity, different from its members, which can be analyzed and could not be reduced to the contribution of each individual in the group.

This idea of social network implies a common knowledge, which is defined by Siemens (2011) as the 'wisdom of crowds,' and a group's network functioning, the same that takes place in Connectivism. This has a number of applications in other sciences, such as economy, with micro- and macro-economic analyses; mathematics, through Graph Theory (Konig, 1936); or even computer science and electronic social media.

The last reference of great relevance to consider for Connectivism can be established in Complex Adaptive Systems (CAS), a field of interdisciplinary study that covers diverse sciences such as psychology, sociology, economy, genetics, biology, artificial intelligence, etc., and are commonly used to describe groups of interrelated elements that react adaptively to the environmental changes affecting them. The term was initially adopted by the Santa Fe Institute led by Holland, Gell-Man and Forrest, but it soon became very popular because of its ability to explain environmental adaptation of complex systems in different fields (Holland, 1996). According to Levin (2002), the main properties of Complex Adaptive Systems are the diversity and individuality of the components, the local and specific interactions between these components, and an autonomous process that uses the results of these interactions to replicate or improve a subgroup of these components; although the property that actually defines a complex adaptive system is, undoubtedly, adaptation. An adaptive system means that the system learns, that there is a competitive selection, and that only the most adequate ones survive the current environment, becoming a norm for replication (Forrest & Jones, 1994).

The idea of learning about Complex Adaptive Systems is essentially the same as Connectivism when considering the functioning of a network or ecology, borrowing many of their affirmations. Connectivism also considers that the network of knowledge adapts to the environment and that the more adequate decision making for the current environment is selected, shaping a Darwinism of networks or systems.

Additionally, the non-defined concept of knowledge according to Connectivism has the qualities of a complex adaptive system. This means that knowledge has no concrete form,

given that it depends on the environment; it is in continuous change or adaptation, constantly expanding and replicating.

1.3. Current references in communication theories and the emergence of the digital revolution

The final step in this theoretical review must be in the present, in more current theoretical movements, contemporary to Connectivism, which have somehow impacted Connectivism, whether inspiring its theories or modifying and perfecting the theoretical foundation on which it is based. Many of these theoretical approaches start from similar ideas, and seek to describe the way of learning of the new society, highly influenced by new information technologies and knowledge, even though their scope, for any reason, has been notably inferior than that of Connectivism, which has had a great positive factor: a policy of open publications that has favored greater repercussion at the international level and in the scientific field (Santamaría, 2010).

The first of the references to consider can be found in the Conversation Theory, originally formulated by Pask (1975) and subsequently restructured by Laurillard (1993, 1999, 2002). According to this theory, the dialogue between the teacher and learner allows for the construction and exchange of knowledge between both interlocutors, in a way that the learner reconstructs the meaning of a certain concept exposed by the teacher and, from this point, the teacher must evaluate the produced learning using his/her own evaluation methods. Therefore, it could be considered that there is intrinsic feedback in the learning process through dialogue, given that at least one adaptation phase of learning must be present in the learner (Martín, García & Ramírez, 2004). This controversial process would serve to make knowledge explicit and promote reflection as Socratic learning. Both Connectivism and Conversation Theory are based on the establishment of relationships as the source of knowledge, either relating ideas or relating with other people and reflecting on it (Lima, 2017).

Another relevant contribution was made by the Actor-Network Theory (ANT), also known as Actant-Rhizome Ontology. This sociological approach emerged in the 1980s, but it was theoretically developed mainly at the end of the 1990s by Latour (1999) and Law (1999). The Actor-Network Theory considers machines, objects, and even discourses, as actants, at the same level as human beings in a symmetrical system in which technological aspects have great relevance (Vidal, 2016). This theory implies that we are all connected, without distinguishing between humans and non-humans. This way, technology, social processes, and human beings are associated and studied at the same level in social analyses.

The arrival of the Internet and the digital revolution means the emergence of new theories based on its functioning and the relationships generated through the digital media. This is the main idea of the Network Learning (N-learning) of Polsani (2003). Inspired by the work of Harasim (1995), Polsani considers that the emergence of the Internet has modified our way of learning, which has derived in the creation of a virtual place of global knowledge production to which we connect, from which we enrich ourselves, and from which we learn throughout life. This network of knowledge and learning would be structured into different layers of knowledge to which we would access based on our needs. Both Connectivism and the theories of Polsani share the idea that knowledge and learning are distributed, can reside in non-human devices, and are

considered live entities which are different from the sum of their elements.

The emergence of the Web 2.0, and its remarkable influence on the new pedagogical methodologies, has derived in the appearance of new theoretical approaches that have influenced some connectivist conceptions and ideas.

[Downes \(2005\)](#), the main promoter of Connectivism together with Siemens, developed the idea of e-learning 2.0., to which he attributes many of the qualities also developed for Connectivism, implying a substantial change with respect to traditional e-learning. According to [Downes \(2005\)](#), e-learning 2.0 implies the integration of the Web 2.0 in teaching, which means that learners participate in their own learning, are able to create content shared with others, can learn through other more informal channels, and that knowledge is alterable, not hierarchically organized but modifiable and adaptable to the learner's need. In short, e-learning 2.0 involves the active participation of electronic learners in their own learning who, in turn, become part of the learning process of other learners with whom they connect ([Osuna & Almenara, 2015](#)).

There are two new education modalities that derive from e-learning both based on small learning portions that are also a clear reference of Connectivism: Microlearning and Nano-Learning.

With regard to Microlearning, according to [Hug \(2007\)](#), very effective learning can be programmed with small activities and very short-term goals. These activities are based on microcontents, which are subsequently used in broader knowledge or in the long term ([Salinas & Marín, 2015](#)). Connectivism also considers the existence and utility of this microlearning, especially in non-intentional or creative learning, which in many cases becomes the first step towards more advanced developments in new subjects or different themes, functioning as explorers of new routes for the network of knowledge.

With regard to Nano-learning or n-learning (this should not be confused with N-learning: Network Learning), this implies a miniaturization of learning, even greater than in Microlearning. Making an analogy with nanotechnology, learning is atomized at its minimum expression (continued dedication of a bit over a minute), ensuring great attention performance and a very high discovery understanding, allowing for a broad diversification and customization of learning by the learner ([Masie, 2006](#); [Imran & Kowalski, 2014](#)).

Continuing with the new tendencies based on new technologies, [Barnes & Tynan \(2007\)](#) address the need of a new university, given that current university students are already users of the Web 2.0. and think that instruction centered on teachers and their knowledge is insufficient. The term Web 2.0 emerged to refer to the new Internet pages that distinguished themselves from more traditional websites covered under the term Web 1.0. The differentiating feature is the collaborative participation of users; this new university is called University 2.0 and consists of emphasizing the new social media technologies in the university sphere ([Esteve, 2016](#); [Ganino, 2017](#)). This way, the student will be able to contribute knowledge while being enriched from it, avoiding the isolation of university contents from the student's reality. Just like in Connectivism, this new university will give great relevance to informal knowledge, traditionally seen in the university sphere as minor learning.

In relation to these ideas of adapting the entire educational sphere to the new 2.0 virtual reality, other authors dare to talk about the existence of a new Curriculum 2.0., with the characteristics of these new technologies (Sobrino, 2014). The curriculum is negotiated between the students and the teacher, and would be guided by the learner's needs (Bawden, Robinson, Anderson, Bates, Rutkauskiene, & Vilar, 2008). Thanks to this customized curriculum, students will develop greater knowledge access and management skills, as it would be adapted to their rhythm and needs, implying the application of connectivist principles.

According to authors like McLoughlin & Lee (2007), the new information technologies applied to knowledge and teaching require substantial changes for the implementation in pedagogy in today's world. This new way of addressing teaching is called Pedagogy 2.0 and must be in line with the learner's needs in today's world (Hardman, 2015). Some of the most important current demands are participation in learning communities and networks (whether social or virtual), customization of learning tasks for each learner's rhythm, and emphasis on knowledge production, that is, contributing to knowledge while being enriched from it (McLoughlin & Lee, 2008). These characteristics of customized learning, rupture of isolation in the teaching context, and horizontal and democratic knowledge are also essential ideas of Connectivism.

The introduction of new technologies in the pedagogical context may imply an important contribution to pedagogy, beyond the traditional conceptualization as distractors. Brown (2006) considered the use of these communication devices (mobiles, tablets, etc.) as an activity that is directly related to the efficient management of affordable information and communication. Learners must interact with other learners and teachers, associate knowledge from their own perspective with their previous knowledge, and share their discovered knowledge and their own learning process with other learners. Brown (2006) called this new perspective Navigationism, with continued management of information and social interaction as its backbone (Organista, McAnally & Lavigne, 2013).

1.4. Connectivism at the present time

As mentioned above, Connectivism as such is a very young trend that has developed in the peak of the digital era. When reflecting about the statements of Sangrá & Wheeler (2013), Solórzano & García (2016) stated that Connectivism describes learning as an opportunity to share knowledge and experiences with others.

Solórzano & García (2016) indicated the following six principles of Connectivism:

1. Psycho-pedagogical base of network learning: Separated from the idea that learning is inherent and exclusive to the individual, to become the patrimony of the collective.
2. The ability to critically select the information to study.
3. Social nature of learning, as social media are used to build knowledge.

4. Given that social media users are “prosumers,” it is clear that active learning takes place.
5. The integration of individuals is encouraged, as they are part of a network.
6. As it can be deduced from the previous points, digital technology has an essential role in the educational process.

Current statistics show how university studies have increased in the last years by 5% in Spain, and master’s degrees by 26%. Additionally, instruction using the Internet as main tool has grown 900% since 2000 at the global level, as claimed by [Muñiz \(2017\)](#) in *El Mundo*.

Accordingly, as stated by [Viñals & Cuenca \(2016\)](#), a society immersed in the “digital era” can be illustrated, where all citizens are exposed to an environment of constant change promoted by digital advances and the Internet, due to the creation of new forms of communication, work and information that solidify the “network society” ([Castells, 2006](#)). However, as stated by [Bringué & Sádaba \(2009\)](#), handling the different technological resources is not enough, given that having an adequate digital competence is also required. This is because ICTs have brought new literacies that are typical of the 21st century, adding competences that enrich from practice with the different digital resources, which are mainly developed by the youth during their free time ([Busquet, Medina & Ballano, 2013](#); [Viñals & Cuenca, 2016](#)).

When we talk about today’s pedagogical trends in which students are responsible for their own educational process, that is, student-centered trends, [Casanova, Pérez, Mar, Chua, Guzmán & Vincent \(2016\)](#) asserted that the advantage of this theory is that it is possible to share, collaborate, discuss, and reflect with others; learning stops being individualistic to become a cooperative and collaborative process. In the former, teachers design and maintain practically full control of the structure of interactions and results that will be obtained; in the latter, it is the other way around, as students design the structure of interactions and maintain control on the different decisions that will affect their learning; spaces where the development of individual and group discussion skills between students are favored at the time of exploring new concepts.

Therefore, current learning differentiates from that produced in the past in that it can be understood as diverse and disorganized, with network knowledge based on the creation of contents and information.

However, it is important to remember what e-learning is and its main differences with respect to in-person learning. To this end, the work of [Cabero & Gisbert \(2005\)](#), summarized in the following table (Table 2), which can serve as a reference.

Table 2:

Characteristics of in-person and network-based instruction

<i>Network-based instruction</i>	<i>Traditional in-person instruction</i>
<ul style="list-style-type: none"> - It allows students to learn at their own pace. - It is a just-in-time training. - It allows the combination of different materials (auditory, visual and audiovisual) - With one single application, a greater number of students can be trained. - Knowledge is an active construction process. - It tends to reduce training time for people. - It is usually interactive, both between the participants of the process (teacher and students) and among contents. - It tends to be carried out individually, without waiving collaborative proposals. - It can take place at the workplace and during the student's free time. - It is flexible. - We have little experience using it. - The structural and organizational resources necessary for its functioning are not always available. 	<ul style="list-style-type: none"> - It is founded on a knowledge base, to which the student must adapt. - Teachers determine when and how students will receive the training materials. - It is based on the assumption that subjects receive knowledge passively to give rise to innovative, critical and research attitudes. - It tends to be centered on print materials and on the teacher as a source of introduction and structuring of information. - It usually uses a linear communication model. - Communication takes place between the teacher and the student. - Teaching is developed mainly in groups. - It can be prepared to take place at a certain time and place. - It takes place at a scheduled time and a specific classroom. - Characteristic temporal rigidity. - We have plenty of experience using it. - We have many structural and organizational resources for its implementation.

Source: Retrieved from [Cabero & Gisbert \(2005\)](#).

Conclusions

Having presented all references and backgrounds related to Connectivism, as affirmed by the initial thesis, it can be clearly concluded that this theoretical trend is more of an evolution of the existing theoretical knowledge than an authentic theoretical revolution.

The main reason why the opposite may be considered is because of the analogy that can be made between the current socio-technological revolution and what Connectivism means in the pedagogical sphere. While in the socio-technological aspect there is no doubt that we are immersed in an authentic revolution that is modifying the established basis, in the field of pedagogy and knowledge, the evolution implies small changes of perspective, new forms of dealing with socio-pedagogical challenges, and new possibilities of addressing future challenges in the educational sphere, taking advantage of the broad current knowledge to strengthen its foundations and face a future that is too uncertain with improved guarantees.

Currently, the theoretical educational approach of Connectivism gives us many advantages that have favored its imposition as new theoretical paradigm of education for most new researchers. These advantages can be summarized as follows:

- Continuity with respect to existing educational knowledge, given that connectivist principles do not imply rupture, but a change of focus, in most circumstances.
- Ease of application of connectivist principles to the new technologies and educational methodologies, being in line with most current tendencies.
- High capacity of adaptation to new generations of 'Digital Native' students that increasingly identify with the needs described by Connectivism.
- Greater harmony between the different sciences and fields of study, as Connectivism is an approach enriched from different theoretical spheres (social psychology, communication technologies, neuroscience, IT, etc.).
- Greater understanding of the current educational situation and future challenges, as Connectivism has a broader understanding of a constantly changing society and knowledge in constant expansion.

However, the important role teachers have in students' learning should not be overlooked, as their work as an active bridge for behaviors and interests that are not particularly focused on learning is crucial. Teachers act as support, and as 'translators,' to facilitate abstraction and learning in educational contexts.

In sum, a very possible expansion and popularization of Connectivism can be envisaged and justified in the educational sphere, taking into account today's evolution of information technology and social media, which are unstoppable, advancing and expanding to all aspects of social life in our community. Therefore, the educational sphere must adapt to the new perspectives by integrating its principles in the best way possible in order to ensure the best education possible for future students.

It can also be affirmed that, as it was shown throughout this paper, Connectivism is introduced as the methodological basis of e-learning processes, and it can even be considered a theory mainly developed for this type of distance learning.

References

- Abrio, A. & Bermúdez, J. (2017). ¿Hacia dónde va el rol del docente en el siglo XXI? Estudio comparativo de casos reales basados en las teorías constructivistas y colectivista [Where is the Teacher's Role Heading in the 21st Century? Comparative Study of Real Cases based on Constructivist and Collectivist Theories]. *Hekademos: Revista Educativa Digital*, (22), 84-92. Retrieved from: <https://dialnet.unirioja.es/descarga/articulo/6280736.pdf>

- Aguilar, J. & Mosquera, D. (2015). Middleware Reflexivo para la gestión de Aprendizajes Conectivistas en Ecologías de Conocimientos (eco-conectivismo) [Reflective Middleware for the Management of Connectivist Learning in Ecologies of Knowledge (Eco-Connectivism)]. *Latin American Journal of Computing*, 2(2), 25-32. Retrieved from: <http://lajc.epn.edu.ec/index.php/LAJC/article/view/87>
- Arenas, A. (2018). La escuela bajo los preceptos de la teoría del caos: Incertidumbre, caos, complejidad, lógica difusa y bioaprendizajes [The School under the Provisions of Chaos Theory: Uncertainty, Chaos, Complexity, Fuzzy Logic and Biological Learning]. *Revista Internacional de Educación y Aprendizaje*, (6(1), 1-9. Retrieved from: <https://journals.epistemopolis.org/index.php/educacion/article/view/360/1087>
- Ausubel, D. (1964). Some psychological aspects of the structure of knowledge. In: ELAM, S. (Ed.) Education and the structure of knowledge. Illinois: Rand MacNally.
- Barnes, C. & Tynan, B. (2007). The adventures of Miranda in the brave new world: learning in a Web 2.0 millennium. *Research in Learning Technology*, 15(3), 189-200. Retrieved from: <https://journal.alt.ac.uk/index.php/rlt/article/view/954/1205>
- Bawden, D., Robinson, L., Anderson, T., Bates, J., Rutkauskiene, U. & Vilar, P. (2008). Towards Curriculum 2.0: library/information education for a Web 2.0 world. *Library and information Research*, 31(99), 14-25. Retrieved from: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.920.5370&rep=rep1&type=pdf>
- Bringué, X. & Sádaba, CH. (2009). La Generación Interactiva en España. Niños y adolescentes ante las pantallas [Interactive Generation in Spain: Children's and Adolescents' Screen Time]. Pamplona: Ariel. Retrieved from: <http://goo.gl/FIXezM>.
- Brown, T. H. (2006). Beyond constructivism: navigationism in the knowledge era. *On the Horizon*, 14(3), 108-120. <https://doi.org/10.1108/10748120610690681>
- Bruner, J. (1966). *Toward a theory of instruction*. Cambridge: Harvard University Press.

- Bruner, J. (2001). El proceso mental en el aprendizaje [The Mental Process in Learning]. Barcelona: Narcea.
- Busquet, J., Medina, A. & Ballano, S. (2013). El uso de las TRIC y el choque cultural en la escuela. Encuentros y desencuentros entre maestros y alumnos. [The Use of ICTs and the Cultural Shock in School. Encounters and Missed Encounters between Students]. *Revista Mediterránea de Comunicación* 4(2), 115-135. DOI: <http://dx.doi.org/10.14198/MEDCOM2013.4.2.06>
- Cabero, J. & Gisbert, M. (2005). Formación en Internet. Guía para el diseño de materiales didácticos [Internet Instruction: Guide for the Design of Didactic Materials]. Seville: MAD.
- Casanova, M., Pérez, M., Mar, M., Chua, A., Guzmán, J, & Vincent, M. (2016). Medios Emergentes Digitales: "Una Experiencia en el Aula" [Emerging Digital Media: An Experience in the Classroom]. Retrieved from: <https://www.cidui.org/revistacidui/index.php/cidui/article/view/897>
- Castells, M. (1999). La era de la información I. La sociedad red [The Information Era I: The Network Society]. Madrid: Alianza.
- Castells, M. (2006). La sociedad red: una visión global [The Network Society: A Global Vision]. Madrid: Alianza Editorial.
- Cathalifaud, A. (2014). La construcción del conocimiento fundamentos epistemológicos del constructivismo [The Construction of Knowledge: Epistemological Foundations of Constructivism]. *Investigaciones Sociales*, 8(12), 271-287. Retrieved from: <http://revistasinvestigacion.unmsm.edu.pe/index.php/sociales/article/view/6897/6104>
- Colom, A. (2005). Teoría del Caos y Práctica Educativa [Chaos Theory and Educational Practice]. *Revista Galega do Ensino*, 13(47), 1325-1343. Retrieved from: <http://dialnet.unirioja.es/descarga/articulo/2554834.pdf>
- Downes, S. (2005). Feature: E-learning 2.0. *E-learn Magazine*, 2005(10), 1-15.

Downes, S. (2008). Connectivism and its critics: What connectivism is not. Retrieved from: <http://www.downes.ca/post/53657>

Downes, S. (2016). The Theory of Connectivism: Can It Explain and Guide Learning in the Digital Age? *Journal of Higher Education Theory and Practice*, 8, 11-26. Retrieved from: http://m.www.na-businesspress.com/JHETP/ForoughiA_Web15_5_.pdf

Duffy, T. M., & Jonassen, D. (2013). *Constructivism and the technology of instruction: A conversation*. London: Routledge.

Esteve, F. (2016). Bologna y las TIC: de la docencia 1.0 al aprendizaje 2.0. [Bologna and ICT: from Teaching 1.0 to Learning 2.0]. *La Cuestión Universitaria*, (5), 58-67. Retrieved from 2018 from: <http://polired.upm.es/index.php/lacuestionuniversitaria/article/view/3337/3402>

Flórez, S., Pérez, J. & Amaya, Á. (2017). Sinergia entre e-Learning y e-Commerce [Synergy between E-Learning and E-Commerce], *Tecnología Investigación y Academia*, 5(1), 91-106. Retrieved from: <http://revistas.udistrital.edu.co/ojs/index.php/tia/article/view/12014/pdf>

Forrest, S. & Jones, T. (1994). Modeling complex adaptive systems with Echo, in R.J. Stonier and X.H. Yu, eds. *Complex Systems: Mechanisms of Adaptation*. IOS Press, Amsterdam. pp. 3-21.

Forster, T. (2008). Connectivism Is. Online Connectivism Conference: University of Manitoba. Retrieved from: https://archive.org/details/ERIC_EJ815759/page/n0

Freud, S. (1984). *La interpretación de los sueños: obras completas [The Interpretation of Dreams: Complete Works]*. Buenos Aires: Amorrortu, 4.

Fuentes, F. (2017). El cambio de conceptos y teorías en el conocimiento científico y ordinario [The Change of Concepts and Theories in Scientific and Ordinary Knowledge]. *Educación y Humanismo*, 19(33), 253-270. DOI: <http://dx.doi.org/10.17081/eduhum.19.33.2643>

- Gagné, R. (1971). *Las condiciones del aprendizaje [Conditions of Learning]*. Madrid: Aguilar.
- Ganino, G. (2018). Didáctica de la web conference en el ámbito universitario [Web Conference Didactics in the University Sphere]. *Educación y Humanismo*, 20(34), 15-35. DOI: <http://dx.doi.org/10.17081/eduhum.20.34.2856>
- Harasim, L. (1995). *Learning networks: A field guide to teaching and learning online*. MIT press.
- Hardman, E. (2015). How pedagogy 2.0 can foster teacher preparation and community building in special education. *Social Inclusion*, 3(6), 42-55. Retrieved from: <https://www.cogitatiopress.com/socialinclusion/article/view/415/415>
- Holland, J. H. (1996). *Hidden order: how adaptation builds complexity*. New York, NY: Addison-Wesley.
- Hug, T. (2007). *Didactics of microlearning*. New York, NY: Waxmann Verlag.
- Imran, A. S., & Kowalski, S. J. (2014). HIP–A technology-rich and interactive multimedia pedagogical platform. In *International Conference on Learning and Collaboration Technologies*, (14), 151-160. Springer, Cham. Retrieved from: https://link.springer.com/chapter/10.1007%2F978-3-319-07482-5_15
- Islas, C. & Delgadillo, O. (2016). La inclusión de TIC por estudiantes universitarios: una mirada desde el conectivismo [The Inclusion of ICT by University Students: A View from Connectivism]. *Apertura: Revista de Innovación Educativa*, 8(2), 116-129. Retrieved from: <https://dialnet.unirioja.es/descarga/articulo/5658842.pdf>
- Konig, D. (1936). *Theorie der endlichen und unendlichen Graphen*, Leipzig: Akad. Verlagsges. mbH.
- Latour, B (1999). "On Recalling ANT," in Law and Hassard, eds., *ActorNetwork Theory and After*. Oxford: Blackwell Publishers, pp. 15-26.

- Laurillard, D. (1993). *Rethinking University Teaching: A Framework for the Effective Use of Educational Technology*. London: Routledge.
- Laurillard, D. (1999). A Conversational Framework for Individual Learning Applied to the Learning. *Systems Research and Behavioral Science*. (16), 113-122. [http://dx.doi.org/10.1002/\(SICI\)1099-1743\(199903/04\)16:2%3C113::AID-SRES279%3E3.0.CO;2-C](http://dx.doi.org/10.1002/(SICI)1099-1743(199903/04)16:2%3C113::AID-SRES279%3E3.0.CO;2-C)
- Laurillard, D. (2002) *Rethinking university teaching: A conversational framework for the effective use of learning technologies* (2nd ed.). London: Routledge Falmer
- Law, J. (1999). "After ANT: Complexity, Naming and Topology." In Hassard, J & Law, J. (ed.) *Actor-Network Theory and After*. Oxford: Blackwell Publishers.
- Levin, S.A. (2002). Complex adaptive systems: Exploring the known, the unknown and the unknowable. *Bulletin (new series) of the American Mathematical Society*, 40(1), 3–19.
- Lewin, K. (1938). The conceptual representation and measurement of psychological forces. *Duke University. Contributions to Psychological Theory*, 1(4), 247-255.
- Lima, G. (2017). Dos modelos: aprendizaje colaborativo on line y comunidad de investigación [Two Models: Online Collaborative Learning and Research Community]. In 4th Seminar on ICT and Innovation at the Classroom (La Plata, 2017). Retrieved from: <http://sedici.unlp.edu.ar/handle/10915/65783>
- Lozares, C. (2005). Bases sociometodológicas para el análisis de redes sociales [Socio-Methodological Basis for the Analysis of Social Media]. *ARS. Empiria: Revista de Metodología de Ciencias Sociales*. 10(2), 9-35. Retrieved from: <http://espacio.uned.es/fez/eserv.php?pid=bibliuned:Empiria-2005-CBBC327E-F8AE-F864-2A0C-B2AC936A8A8C&dsID=Documento.pdf>
- Maldonado, C. (2017). Educación compleja: Indisciplinar la sociedad [Complex Education: Interdisciplinating Society]. *Revista Educación y Humanismo*, 19(33), 234-252. DOI: <https://doi.org/10.17081/eduhum.19.33.2642>

- Masie, E. (2006). Nano-Learning: miniaturization of design. *Chief Learning Officer*, 5(1), 17-25.
- Mayer, R. (1992). Cognition and instruction: Their historic meeting within educational psychology. *Journal of Educational Psychology*, (84), 405-412.
- Martín, T., García, J., & Ramirez, R. (2004). Aplicaciones de la Teoría de la Conversación a entornos docentes telemáticos [Applications of the Conversation Theory to Telematic Teaching Environments]. T. Yousef. Retrieved from: https://www.researchgate.net/publication/237615442_Aplicaciones_de_la_Teoria_de_la_Conversacion_a_entornos_docentes_telematicos
- McLoughlin, C. & Lee, M. (2007). Social software and participatory learning: Pedagogical choices with technology affordances in the Web 2.0 era. In *ICT: Providing choices for learners and learning*. Proceedings ascilite Singapore 2007. Retrieved from: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.471.2008&rep=rep1&type=pdf>
- McLoughlin, C. & Lee, M. J. (2008). The 3 P's of pedagogy for the networked society: Personalization, participation, and productivity. *International Journal of Teaching and Learning in Higher Education*, 20(1). 10-27. Retrieved from: <http://www.isetl.org/ijtlhe/articleView.cfm?id=395>
- Moreno, J. (1962). *Fundamentos de la Sociometría [Foundations of Sociometry]*. Buenos Aires: Piados.
- Mukamel, R., Ekstrom, A., Kaplan, J., Iacoboni, M. & Fried, I. (2010). Single-neuron responses in humans during execution and observation of actions. *Current Biology*. 20(8), 750-6. <https://doi.org/10.1016/j.cub.2010.02.045>
- Muñiz, M. (September 26, 2017). El 'e-learning,' un modelo de formación que gana cada vez más adeptos [E-Learning: an Instruction Model Becoming Increasingly Popular]. *El Mundo*. Retrieved from: <https://www.elmundo.es/extras/formacion->

online/2017/09/26/59ca90a1ca4741900e8b4601.html

- Nobles, D., Londoño, L., Martínez, S., Ramos, A., Santa, G. & Cotes, A. (2016). Tecnologías de la comunicación y relaciones interpersonales en jóvenes universitarios [Communication Technologies and Interpersonal Relationships in Young University Students]. *Educación y Humanismo*, 18(30), 14-27. DOI: <http://dx.doi.org/10.17081/eduhum.18.30.1311>
- Organista, J., Mcanally, L. & Lavigne, G. (2013). El teléfono inteligente (smartphone) como herramienta pedagógica [The Smartphone as Pedagogical Tool]. *Apertura: Revista de Innovación Educativa*, 5(1), 6-19. Retrieved from: <http://www.udgvirtual.udg.mx/apertura/index.php/apertura/article/view/372/311>
- Osuna, J. B. & Almenara, J. (2015). Replanteando el e-learning: hacia el e-learning 2.0 [Reconsidering E-Learning: Towards E-Learning 2.0]. *Campus Virtuales*, 2(2), 76-87. Retrieved from: <http://www.uajournals.com/ojs/index.php/campusvirtuales/article/view/40>
- Papert, S. (1995): La máquina de los niños. Replantearse la educación en la era de los ordenadores [The Children's Machine: Reconsidering Education in the Computer Era]. Barcelona: ed. Paidós.
- Pask, G. (1975). "Conversation, Cognition and Learning". Amsterdam: North Holland Publishing Co.
- Piaget, J. (1954). *The Construction Of Reality In The Child*. London: Routledge.
- Polsani, P. R. (2003). Network learning. In K. Nyíri (Ed.), *Mobile learning: Essays on philosophy, psychology and education* (pp. 139-150). Vienna: Pasagen Verlag.
- Rizzolatti, G., Fadiga, L., Matelli, M., Bettinardi, V., Paulesu, E., Perani, D. & Fazio, F. (1996) Localization of grasp representation in humans by PET: 1. Observation versus execution. *Experimental Brain Research*. (111), 246–252.
- Rivera, P., Alonso, C. & Sancho, (2017). Desde la educación a distancia al e-Learning: emergencia, evolución y consolidación [From Distance Education to E-Learning:

Emergence, Evolution and Consolidation]. *Educación y Tecnología*, (10), 1-13. Retrieved from: <https://dialnet.unirioja.es/descarga/articulo/6148504.pdf>

Rock, I. & Palmer, S. (1990). The legacy of Gestalt psychology. *Scientific American*, 263(6), 84-91.

Rodríguez, J. (2016). La renovación pedagógica: del instrucciónismo intelectualista al holismo educativo [Pedagogical Renovation: from Intellectualist Instructionism to Educational Holism]. *Tendencias Pedagógicas*, (27), 43-76. Retrieved from: <https://revistas.uam.es/tendenciaspedagogicas/article/view/2999>

Salinas, J. & Marín, V. (2015). Pasado, presente y futuro del microlearning como estrategia para el desarrollo profesional [Past, Present and Future of Micro-learning as Strategy for Professional Development]. *Campus Virtuales*, 3(2), 46-61. Retrieved from: <http://uajournals.com/ojs/index.php/campusvirtuales/article/view/59/58>

Sangrà, A., & Wheeler, S. (2013). Nuevas formas de aprendizaje informales: ¿O estamos formalizando lo informal? [New Forms of Informal Learning: Or Are We Making the Informal Formal?]. *RUSC. Universities and Knowledge Society Journal*, 10(1), 15-29. DOI: <http://dx.doi.org/10.7238/rusc.v10i1.1689%3E>

Santamaría, F. (2010). La era conectiva: por el desorden natural de los artefactos y nodos [The Connective Era: Due to the Natural Disorder of Nodes and Devices]. Retrieved from: <http://www.nodosele.com/editorial/wp-content/uploads/2010/01/Introduccion.FernandoSantamaria.Conociendoelconocimiento2.pdf>

Schutt, F. (1995). El pensamiento freudiano en 1895: Estudios sobre la histeria cien años después [Freudian Thinking in 1985: Studies on Hysteria, 100 Years Later]. *The UB Journal of Psychology*, (67), 9-14.

Siemens, G. (2004). Connectivism: A Learning Theory for the Digital Age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 3-10.

Siemens, G. (2006). *Knowing Knowledge*. Morrisville, United States: Lulu.com.

Siemens, G., & Conole, G. (2011). Special issue-Connectivism: Design and delivery of social networked learning. *International Review Of Research in Open and Distance Learning*, 12(3). Retrieved from:

https://www.researchgate.net/publication/50888824_Special_Issue_-_Connectivism_Design_and_Delivery_of_Social_Networked_Learning

- Sobrinó, Á. (2014). Aportaciones del conectivismo como modelo pedagógico post-constructivista [Contributions from Connectivism as Post-Constructivist Pedagogical Model]. *Propuesta Educativa*, (42), 39-48. Retrieved from: http://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1995-77852014000200005
- Solórzano, F. & García, A. (2016). Fundamentos del aprendizaje en red desde el conectivismo y la teoría de la actividad [Network Learning Foundations from Connectivism and the Activity Theory]. *Revista Cubana de Educación Superior*, 35(3), 98-112. Retrieved from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0257-43142016000300008&lng=es&tlng=pt
- Vidal, J. P. (2016). Teoría de sistemas autopoieticos y la actor network theory: ¿Hacia una convergencia posestructuralista? [*Theory of Autopoietic Systems and Actor-Network Theory: Towards a Post-Structuralist Convergence?*]. *INTERthesis: Revista Internacional Interdisciplinar*, 13(2), 38-57. Retrieved from: <https://dialnet.unirioja.es/descarga/articulo/5562180.pdf>
- Viñals B. & Cuenca, J. (2016). El rol del docente en la era digital [The Teacher's Role in the Digital Era]. *Revista Interuniversitaria de Formación del Profesorado*, 30(2), 103-114. Retrieved from: <http://www.redalyc.org/pdf/274/27447325008.pdf>
- Vygotsky, L.S. (1932). *Mind in society: The development of higher psychological processes* (1932). Cambridge, MA: Harvard University Press.
- Wertheimer, M. & Riezler, K. (1944). Gestalt theory. *Social Research*, (5), 78-99.
- Wertsch, J. (1988). *Vygotsky y la formación social de la mente [Vygotsky and the Social Formation of the Mind]*. Barcelona, Spain: Paidós.
- Zapata-Ros, M. (2015). Teorías y modelos sobre el aprendizaje en entornos conectados y ubicuos. Bases para un nuevo modelo teórico a partir de una visión crítica del "conectivismo" [Theories and Models of Learning in Connected and Ubiquitous Environments: Basis for a New Theoretical Model based on a Critical Vision of Connectivism]. *Education in the Knowledge Society*, 16(1), 69-102. Retrieved from: http://campus.usal.es/~revistas_trabajo/index.php/revistatesi/article/view/eks201516169102