

Psychopedagogical Predecessors of Connectivism as a New Paradigm of Learning

Roberto Sánchez Cabrero^a & Óscar Costa Román^a

Received: 30 May 2018 • Accepted: 17 July 2018

Abstract: This article presents an historical overview of the main background theories of Connectivism, understood as a new paradigm of education. The object is to assess whether this new educational paradigm is an evolution from preceding schools or a revolutionary theory in the educational field. Psychoanalysis and the School of Gestalt are presented as the earliest antecedents, and the influence of Instructionism, Constructivism, Chaos Theory, Neuroscience, Network Theory and Theory of Complex Adaptive Systems will be analysed, as they are considered direct predecessors. The article concludes by reflecting the influences of several contemporary schools of educational theories such as the Theory of Conversation, the Actor-network theory, Network Learning, e-learning 2.0., Microlearning, Nano-learning, University 2.0., Curriculum 2.0., Pedagogy 2.0 and Navigationism. These schools complete the theoretical foundations on which Connectivism is based. As a consequence, Connectivism is only the evolution of previous schools and not a theoretical revolution in pedagogy. Its ideas represent the adaptation of previous theories to the current society, where social and communication technologies have changed the bases on which the knowledge and learning are based..

Key-words: Connectivism, Educational Paradigms, Social Network, New Technologies, e-Learning.

1. Introduction

The aim of this review is to present the theoretical bases of Connectivism as a new paradigm of education. This analysis is intended to

^a Alfonso X el Sabio University (Spain). Correspondence: Roberto Sánchez Cabrero, Avenida de la Universidad 1, Edificio D: Despacho D233, 28691-Villanueva de la Cañada. Madrid, Spain. robsan9@gmail.com.

understand the birth of Connectivism as a historical evolution of education. Connectivism is, therefore, the evolution of existing theories within the scientific field adapted to the current society and not a breakup with the previous works. (Verhagen, 2006, Kop and Hill, 2008).

Before going on, it is necessary to define the concept Connectivism and its meaning in the current scientific educational field. It is a complex task because Siemens, the founder of this psychopedagogical school, knew that the knowledge is too perishable and always tried to avoid definitions and close concepts (Siemens, 2004, 2006, 2013).

If we look into the contributions made by the main theorists of Connectivism, it is possible to identify a theoretical basis upon which several principles are settled, as well as an approach to understand it. The reference to “approach” instead of “knowledge theory” or “learning theory” is not a trivial act, because doing so, we elude most of the current criticisms to Connectivism, including those from Downes, one of the founders and main promoters of this theoretical approach in education. (Downes, 2008, 2012; Forster, 2007; Verhagen, 2006).

This connectivist approach implies to emphasise the pragmatic value of the connectivist statements. Connectivism is used to interpret and understand the processes related to learning and knowledge in the current world, particularly regarding the technological evolution of social networks and e-learning. Therefore, the principles of Connectivism should not be used to explain every kind of learning and knowledge as some gaps could be found in its principles. These gaps are covered by previous theories “complemented” by Connectivism in order to adapt them to the digital technological world. (Downes, 2008, 2013).

In its endeavour to understand knowledge and learning, Connectivism defines the human mind as a network which adapts to its environment. Therefore, learning could be defined as the process of creating networks by means of connections among several nodes and knowledge would be held in these networks. The role of the learner is both active and creative because they need to constantly adapt to the changing environment by making new connections, identifying patterns and learning through the decision making experience (Siemens 2006, 2013).

One of the main ideas in Connectivism is that knowledge is something unpredictable, unstable, uncontrollable and in continuous growth, which means that it goes beyond the total control of a person and might be in their external networks (communities, digital devices, etc.) constantly changing. Therefore, Connectivism is not only the idea of individual human knowledge and learning, but also an approach to understand the collective mentality of a network of individuals, a community or a society based on the same principle: the generation of network ecologies constantly changing and evolving.

It is easy to find similarities between the concepts of “human mind” and “knowledge” according to Connectivism and the Internet and the uprising and quick expansion of social networks such as Twitter or Facebook. This situation is understandable because they are human creations which base their success on the suitability to satisfy the human need of learning and developing networks in order to adapt to the environment and hence, to learn. There is where the key of Connectivism lies, because it is certainly the theoretical and psychopedagogical approach most prepared to describe and explain the current world in which social and digital environments are mixed, creating new ways of knowledge and learning which could not be explained by the previous educational theories, because knowledge in this current digital age is unpredictable, disorganized, horizontal, democratic and, overall, in constant and exponential expansion.

2. The Psychopedagogical predecessors of Connectivism

2.1 The early predecessors

The oldest precursor of Connectivism could be found in the psychotherapeutic practice of Psychoanalysis (Freud, 1900, 1953). Connectivism shares some curious similarities with this controversial psychological school, which allows us to do a slight parallelism between them. Both Psychoanalysis and Connectivism share the following features:

- Both schools were created by one only person: Freud (1899) and Siemens (2004), although both received later enriching contributions from different authors.
- Both theoretical schools were created with the aim of explaining some features of human behaviour that their contemporary scientific theories were unable to explain. Freud aimed to understand the human motivation, finding the idea of the “unconscious mind”. Siemens, in turn, tries to complete the gaps and inaccuracies caused by classical learning theories, especially regarding a fast and wide growth of knowledge, which he considers their main weakness (Siemens, 2006).
- Both schools have been strongly criticised as scientific theories, being more advisable to apply them as approaches: therapeutic in the case of Psychoanalysis and educational in the case of Connectivism.
- Both schools had a quick spread and triggered a lot of influence, in their field and in others spheres, gaining a great scientific interest in their time.
- Finally, the main similarity between them is the great importance given to the performance of the human mind as a network. On the

one hand, the Free Association of Ideas technique is key as a therapeutic method in Psychoanalysis (Freud and Breuer, 1895). On the other hand, Connectivism defines learning as the process of connecting information nodes or sources. Therefore, both schools consider a similar human mind performance when thinking or learning, in the form of a network and a generation of links between ideas.

Other early predecessors of Connectivism can be found in Gestalt psychology. Theorists of this school consider the learning process as a development of new ideas or as a modification of the existing ideas (Wertheimer and Riezler, 1944). For this purpose, the learner needs to have an active role, as learning is achieved in a deliberate way, by exploring our environment and circumstances and being creative. This idea is connected to that of Connectivism under which the learning network must be “modified and adjusted”. Siemens considers that the learner builds learning networks which adapt to their current needs and later modifies as their circumstances change (Siemens, 2013).

Similarly to the Gestalt Psychology, Connectivism also considers a global view of reality with a purely pragmatic goal. In both theoretical schools, knowledge is dependent on the global view generated by it. Therefore, knowledge is less important than the view upon which it lies and its meaning can change according to the circumstances. The learner creates their own reality using the elements (knowledge) they have; taking an active role and being creative is, therefore, a key factor to generate learning, which, furthermore, will be completely personal and unique compared to the learning of other learner.

Moreover, it is convenient to emphasize that some of the Gestalt main principles (similarity, proximity, continuation, etc.) are laws that show the way human mind make connections and associations. These laws are also used by Connectivism to show how a knowledge network is created and modified any moment and for any learner.

2.2. Predecessors in pedagogy and psychology sciences

The continuous development of knowledge in pedagogy and psychology has meant a huge source of references for Connectivism. Many authors of great relevance have been recognised as a source of inspiration for the contributions made by some of the most important connectivist authors (Siemens, Downes, etc). Authors like Bruner, Ausubel, Piaget, Bandura, Gagné, etc. and scientific schools like the Theory of Networks, Neuroscience, Instructionism or the Theory of the Chaos have built the basis for the main connectivists' axioms.

As per the traditional juxtaposition of Instructionism and Constructivism in education, Connectivism is undoubtedly much closer to Constructivism (Duffy and Jonassen, 2013). However, some of the ideas of Instructionism have been used as a reference. Considering Instructionism as “the expression of believing that the perfectionism of the instruction leads to a better learning (p.151)”, according to Papert’s definition (1995), it can be observed that Connectivism agrees with Instructionism when claiming that practice and improvement help the learner to achieve a deeper and complex knowledge. For Connectivism, however, this process is not based on the perfection of the instruction but in the improvement of the learner’s decision making based on the improvement of their knowledge network. The richness of this network leads to a more complex view and to a more focused deepening on the learner’s interests.

Regarding Constructivism, this school is defined as the third metaphor in learning according to Mayer (Mayer, 1992):

Learning as	Teaching	Instructional focus	Results
<i>Response acquisition</i>	Feedback provision	Centred in the syllabus (Right behaviour)	Quantitative (Strength of associations)
<i>Information acquisition</i>	Information provision	Centred in the syllabus (Right information)	Quantitative (Amount of information)
<i>Meanings construction</i>	Cognitive guide	Centred in the learner (Significant processing)	Qualitative (Knowledge structure)

Table 1. Three metaphors of learning. Source: Mayer, 1992, from Zapata-Ros, 2012

Within the constructivist view of meanings construction during the learning process, it is advisable to stand out several theoretical approaches from different authors which have also been fundamental for the connectivist theories.

The first constructivist theoretical approach presented as a predecessor of Connectivism is the School of Gestalt, led by Von Wertheimer and Köhler, which was previously mentioned at the early predecessors section herein.

The main promoter of Constructivism in education, Piaget, introduced the importance of interaction with the social environment in his Constructivist Theory of Learning. According to Piaget (1954), learning is constructed through the learner’s maturity and experience in relation with their physical and social environment and thanks to this, the mental structures are modified and extended into more complex ones.

Gagné (1971) is another author who was inspiring for the creation of Connectivism. He claimed there are internal and external determining factors that regulate the learning process, agreeing consequently with the connectivist idea of ecology and adaptation to the social environment. The internal determining factors work as a storehouse for the acquisition of abilities that are a prior requirement to learn; the external determining factors are related to the context that makes the learning process easier.

Another of the most relevant authors in Constructivism, Bruner (1966), presented the concept of Discovery Learning, which means to accept the idea of incidental learning and the appearance of challenges for the learner that might modify their interests and their way to solve problems. Siemens (2004) developed this idea as the complete definition of a problem through the combination of the different points of view of the agents involved by means of their individual creativity, being able to reach a deeper view of the problem through the casual combination of their own interests.

Bruner (2001), in turn, considered the active dialogue learner-teacher as a key factor in learning, which implies the creation of an external learning network that generates knowledge, as the connectivist ideas assert.

Vygotsky has also been a strong inspiration for Connectivism. Vygotsky (1978) presents the idea of competence and considers the social factors as external triggers for learning, working as an external knowledge network; however, its bigger influence in Connectivism is the idea of Zone of Proximal Development, defined as:

"The distance between the actual developmental level of the child as determined by their independent problem solving and the highest level of potential development as determined by the problem solving under adult guidance or in collaboration with their more capable peers" (Vygotsky, 1932, mentioned in Wertsch, 1988; p.84)

This idea of the "Zone of Proximal Development" links directly with the performance of a knowledge network according to Connectivism and coincides with the following connectivist principle: "The ability to increase knowledge is more important than what we already know" (Siemens, 2006; p. 31).

Finally, Ausubel (1964) conceives knowledge as an assignment of meaning process. New knowledge has to be linked to old knowledge, transforming it consequently and thus creating a deeper and more complex knowledge. Through this process, the learner also achieves the ability to adapt to new situations, because they gain a more solid knowledge where the most basic knowledge holds the most complex one, under a hierarchical structure similar to the connectivist "network".

The constructivist metaphor of learning as a Construction of Meaning entailed Cognitivism naturally evolving towards a syllabus more centred in the learner. From this perspective, learners have an active and main role in their own learning process, as they are who construct and organise their own learning through the construction of meaning into the knowledge they are acquiring.

The constructivist perspective of Cognitivism has been predominant from the '80s until now in the educational scientific field. At present, this perspective represents multiple changes in the educational configuration of learning in schools, serving as a reference to new educational methodologies that are being currently introduced, such as Project-based Learning, learning corners, etc. (Cathalifaud, 2014).

Connectivism agrees with Constructivism in a big part of this global view of the learner, as Connectivism also considers that the learner has a main role in the learning process and gives them an active role when choosing contents and organising them according to a unique and own meaning. However, both theories differ in a fundamental aspect, as Connectivism rejects the idea of meanings being constantly constructed.

According to Connectivism, the learner is not constantly constructing because it means an attempt to organise the chaos of the learner's achievable knowledge. Sometimes, the learner just surf through this chaos without the need of organise it, or even disorganising what was previously organised. Therefore, as Siemens claims: "We are not always constructing (which implies a cognitive work), but we are constantly making connections" (Siemens, 2006, p.27).

This critique from Connectivism to Constructivism leads us to another psycho-pedagogical predecessor of Connectivism: the Chaos Theory applied to Education. According to the Chaos Theory, any social issue is unfinished and is based on distorting and chaotic events that create disorder from the order and vice versa. That is why education, as a social science, should be based on this perspective (Castells, 1999). Moreover, in a cognitive level, creativity is considered the chaotic engine of the intelligence (Colom, 2005). Creativity opens the doors to the disorder generated by the acquired knowledge in the learner and drives it to new and complex heights that can be organised in a higher level and so on indefinitely.

It is easy to see the connection between Connectivism and these Chaos Theory principles. Connectivism, similarly to Chaos Theory, does not consider that learning is guided, creates a cognitive order and is intentional. They also agree in the idea of knowledge being constantly fluctuating, meaning that current knowledge is perishable and becomes the ground of new knowledge. However, the scope of the Chaos Theory to define the learning acquisition of the learner is more limited, as this theory does not consider that the connexion nodes are points of support to define each learner's learning so there would

not be any basis to hold the decision-making process. According to the Chaos Theory there is not a clear structure to guide the learner and, therefore, all learners might be similar or similarly different. In Connectivism, the before mentioned knowledge network made of nodes structures learning and knowledge and also is the basis, in a non-deterministic way, for future learning processes with a personality which is not only fluctuant but also particular and personal. This personality is not determined by the Chaos Theory.

Current scientific advances in Neuroscience have also meant a strong support for connectivist theories. Discoveries in cognitive neuroscience related to the operation of mirror neurons, discovered by Rizzolatti et. al. (1996) confirm the connectivist idea of knowledge being able to become a reality in the human mind without the intervention of symbolic aspects and therefore, without the constant creation of meanings.

Initially, mirror neurons were thought to be executors of imitation features in the human being, but it has been discovered that they can go much further. According to numerous studies, this neuronal system, mainly present in the frontal parietal area of the cerebral cortex, makes it possible for the human being to feel the feelings, emotions and even actions perceived in others as their own. These findings suggest that multiple systems in humans might be fitted with neuronal mechanisms of reflex, both for the integration and differentiation of perceptive and motor aspects of the actions performed by ourselves and also by others (Mukamel, Ekstrom, Kaplan, Iacoboni and Fried, 2010). Connections with Connectivism are clear and two ideas are reinforced. The first idea is that knowledge is distributed not only in a human being but also through our interspecies' empathy, which can also be found in non-human devices (a film, a song, an Internet browser, etc). The second idea is that human beings are continuously making connections beyond their cognitive analysis, expanding their knowledge in the shape of a network.

The main reference to link Connectivism to social or sociopsychological sciences can be found in the Network theory. This theory has its origin in the School of Gestalt and was given a first boost with the works about group's psychology of Lewin (1938) and the sociometry studies of Moreno (1962). Theorists of this proposal aim to analyze the behaviour as a group of a people network assuming that what people feel, think and do as a group has its origin and is shown in the guidelines of the situational relationships between them and not in their individual characteristics (Lozares, 2005). Therefore, a network would have an identity of its own and different in relation with its members, could be analyzed and would not be reducible to the contribution of each member.

This idea of social network implies a common knowledge, defined by Siemens (2013) as "Wisdom of crowds", and a network performance as a group, similarly to what happens with Connectivism. Moreover it has several applications in other sciences such as economics with micro and macro analy-

sis, mathematics through the “Graph theory [2] or computer science and the electronic social networks.

The last relevant reference for Connectivism can be established in the Complex Adaptive Systems (CAS) [3]. Complex Adaptive Systems are an interdisciplinary field of study which includes several sciences such as psychology, sociology, economics, genetics, biology, artificial intelligence, etc. and are commonly used to describe groups of interrelated elements that react in an adaptive way to the environmental changes. This term was initially adopted by the Santa Fe Institute in the 90s with Holland, Gell-Man and Forrest in the lead but it was easily popularized thanks to its potential to explain the environmental adaptation of complex systems within several sciences (Holland, 1996). According to Levin (2002), the main characteristics of the Complex Adaptive Systems are the diversity and individuality of its components, the local and specific interactions between those components and an autonomous process that uses the interactions results to replicate or improve a subset of said components; however, the feature that really defines a complex adaptive system is the adaptation. When a system adapts, it means that it learns, that there is a competitive selection and that only the more appropriate components survive, becoming the rule for replication (Forrest and Jones, 1994).

The concept of “learning” in Complex Adaptive Systems is mainly the same than in Connectivism concerning the performance of a network or ecology and for that reason Connectivism uses many of their statements. Connectivism also considers that the knowledge network changes by adaptation to the environment and only the most suitable decisions making for the current situation are selected, creating a network or system Darwinism. Also, the non-defined concept of “knowledge” according to Connectivism has the features of a complex adaptive system, meaning that knowledge does not have a defined shape because it depends on each specific environment, is under constant change or adaptation and expands and replicates constantly.

3. The more recent predecessors

This article, intended to reflect the basis of Connectivism, would not be completed without the reference to the most recent theoretical movements, contemporary with Connectivism, which in some way have left a mark on it, either inspiring its theories or modifying and improving its theoretical basis. Many of these theoretical approaches start from similar ideas and try to describe the process of learning in a society heavily influenced by new knowledge and information technologies, although for some reasons they had a minor impact compared to Connectivism, which has had a policy of open publications that has favoured a bigger international and scientific impact. (Santamaría, 2010, 2013).

The first reference to include is the Conversation Theory, originally suggested by Pask (1975) and later restructured by Laurillard (1993, 1999). According to this theory, the dialog between teacher and learner allows the construction and exchange of knowledge between them. In this way, the learner rebuilds the meaning of a given concept explained by the teacher and from this point, the teacher has to assess the learning using his own assessment methods. Therefore, it might be considered that there is an intrinsic feedback in the learning process through dialog because at least one phase of adaptation of the learning process by the learner has to be present (Martín, García Rueda and Ramírez Velarde, 2004).

This conversational process would be used to make knowledge explicit and to encourage the reflection as a Socratic method of learning. Both Connectivism and Conversation Theory are based in the creation of relationships as a source of knowledge, both through the connection of ideas and making relations with other people and thinking about it.

Another important reference is the Actor-Network Theory (ANT) [4], also known as “actant-rhizome ontology”. It is a sociological approach born in the 80s but theoretically developed at the end of the 90s mainly with the works of Latour (1999) and Law (1999). The Actor-Network Theory considers machines, objects and even discourses as actors at the same level than human beings, in a symmetric system where technological aspects develop a great importance. This theory implies that everything is connected with no distinction between human and non-human beings, and therefore technology, social processes and human beings are associated and studied at the same level in social analyses.

Another reference to analyze is the Network Learning (N-learning) of Polsani (2003), inspired in the works of Harasim (1995). Polsani suggests that the birth of the Internet has modified our way of learning, ending up in the creation of a place where virtual global knowledge is produced and to which we connect, enrich ourselves and learn through all our life. This network of knowledge and learning would be structured in different levels of knowledge and we would drive into these levels according to our needs. Both Connectivism and N-learning share the idea that knowledge and learning are distributed, can be found in non-human devices and are considered as live entities which are different from all their elements as a whole.

The birth of the Web 2.0 and its important influence over new pedagogic methodologies have motivated the creation of new theoretical approaches with influence in connectivist ideas.

Downes (2005), the main promoter of Connectivism together with Siemens, develops the idea of e-learning 2.0, with many features in common with Connectivism, which means an important change compared with the traditional e-learning. According to Downes (2005), e-learning 2.0 implies the integration of the Web 2.0 into the learning process. It means that the learner

takes part in their own learning process, is able to create contents and share them with others, learning can be done through more informal channels and knowledge is changeable, i.e. it is not organized in a hierarchical way and it can be modified or adapted according to the learner's needs. In conclusion, e-learning 2.0 implies an active participation of the electronic learner in their own learning process, even being a part of the learning process of other learners he is connected to.

Two new branches of education derived from e-learning and based on small pieces of learning are also clear references for Connectivism. These new branches are Microlearning and Nano-learning.

Regarding Microlearning, Hug (2005, 2007) claims that it is possible to schedule very effective learnings by means of small activities and short-term goals. These activities are based on micro-contents that are used later in wider knowledge or in the long term. Connectivism also considers the existence and usefulness of this microlearning, mainly in non intentional or creative learning, being in many circumstances the first steps towards a more advanced development in new subjects or different topics and working as an explorer for new routes in the knowledge network.

Regarding nano-learning (n-learning: nano-learning; do not confuse with N-learning or Network Learning), it implies a learning miniaturization even bigger than Microlearning. Drawing an analogy between nano-learning and nanotechnology, learning is subdivided up to the maximum (with a continued focus of only a bit longer than one minute), which guarantees a great performance in attention and a very high understanding by discovery, allowing a great diversification and customization for the learner (Masie, 2006).

Continuing with new tendencies based on new technologies, Barnes and Tynan (2007) present the need of a new university, because current university students are already users of the Web 2.0. and think that education based on the teacher and his knowledge is not sufficient. The term Web 2.0 arose to name the new webpages different from the web sites more traditional and called Web 1.0; the distinguishing feature is the collaborative participation of users. This new university is called University 2.0 and consists in putting an emphasis on new social network technologies within the university context. This way, the learner will be able to contribute knowledge while they are also learning and there will be no separation between the university content and the learner's reality. In this new university, similarly to Connectivism, the informal knowledge, which always has been considered as a minor learning in the university context, will acquire a great relevance. (Abella, Santamaría & Grande, 2010).

Linked to these ideas of adapting the whole educational context to the new virtual reality 2.0, other authors suggest the existence of a Curriculum 2.0 with the features of these new technologies. Curriculum is agreed between

students and teachers and is guided by the learner's needs (Bawden, Robinson, Anderson, Bates, Rutkauskine and Vilar, 2008). Thanks to this new customized curriculum the students would develop better management skills and access to knowledge, as this would be adapted to their learning pace and needs, which means an application of the connectivist principles.

According to authors such as McLoughlin and Lee (2007), the application of new information technologies to knowledge and education require important changes in pedagogy in the current context. This new way of handling education is called Pedagogy 2.0 and has to be adapted to the learner's needs in the current society. Some of the most important current requirements are the participation in learning networks and communities (whether social or virtual), the customization of learning activities according to each learner's pace and the emphasis on the production of knowledge, that is, to contribute knowledge and to receive knowledge. These features of customized learning, rupture of the learning context isolation and the horizontal and democratic knowledge are also basic ideas in Connectivism.

The introduction of new technologies in a pedagogical context can mean a great contribution to pedagogy, changing the usual concept of distraction. Brown (2006) considers the use of these communication devices (mobile phones, tablets, etc.) as an activity directly related to the efficient management of achievable information and communication. Learner has to be in contact with other learners and teachers, connect knowledge from their own perspective with their previous knowledge, share discovered knowledge and collaborate with other learners in their own learning process. Brown (2006) denominates this new perspective Navegacionism, whose bases are information management and continuous social interaction (Organista-Sandoval, McAnally-Salas and Lavigne, 2013).

4. Conclusion

After having presented all the references and predecessors related to Connectivism, it can be clearly concluded that this theoretical approach means an evolution from the existing theoretical knowledge instead of a real theoretical revolution, as it was stated in the initial thesis.

The main reason to think otherwise can be found in the analogy usually drawn between the current socio-technological revolution and the impact that Connectivism has in the pedagogical field. Whereas in the socio-technological aspect there is no doubt that it means a real revolution that modifies the existing basis, in Pedagogy and knowledge the evolution only suggests little adjustments and changes of perspectives, new ways of dealing with socio-pedagogical challenges and new chances to approach future opportunities in the educational context, which take advantage of the current great knowledge

in order to reinforce their basis and face a rather unclear future with better guarantees.

Currently, the learning theoretical approach of Connectivism offers numerous advantages that allow it to become the new learning theoretical paradigm for the vast majority of new researchers. These advantages can be summed up as the following:

- Continuity with the existing educational knowledge, as in most cases connectivist principles do not mean a rupture but a new approach.
- Easy application of connectivist principles to new technologies and learning methodologies, as it is in line with most of the current trends.
- High adaptation to the new generations of “digital natives” students, who increasingly identify themselves with the needs described in Connectivism.
- Higher coordination among different sciences and fields of study, as Connectivism is an approach which takes information from different theoretical fields to develop (Social psychology, information technology, neuroscience, computing science, etc.).
- Better comprehension of the current learning situation and future challenges, as Connectivism foresees a better understanding of a society in constant change and a knowledge continuously growing.

In conclusion, it can be predicted and justified a probable expansion and popularization of Connectivism in the educational context, considering the current evolution of information technologies and social networks, which for the moment are quickly expanding into every aspect of our community social life. For that reason, the educational context has to be adapted to new perspectives fitting in its principles in the best possible way and use these principles in order to guarantee the best possible education.

References

- Abella, V., Santamaría, F. & Grande, M. (2010). *Web 2.0 & Escuela 2.0: Los Nuevos Escenarios de Aprendizaje*. Wordpress.com. Recovered from: <https://mariogrande.files.wordpress.com/2010/12/web-2-0-y-escuela-2-0-los-nuevos-escenarios-de-aprendizaje.pdf>
- Ausubel, D. P. (1964). Some Psychological Aspects of the Structure of Knowledge. In S. Elam (Ed.) *Education and the Structure of Knowledge* (pp. 221-262). 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.
- Bawden, D., Robinson, L., Anderson, T., Bates, J., Rutauskiene, U. & Vilar, P. (2007) Curriculum 2.0? Changes in Information Science Education for a Web 2.0 World. Presented at *INFuture 2007: 1st International Conference on the Future of Information Sciences. Digital Information and Heritage Conference*, Zagreb, Croatia, 7-9 November 2007.
- 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.
- Brown, T. H. (2006). Beyond Constructivism: Navigationism in the Knowledge Era. *On the Horizon*, 14(3), 108-120.
- Bruner, J. (1966). *Toward a Theory of Instruction*. Cambridge: Harvard University Press.
- Bruner, J. (2001). *El Proceso Mental en el Aprendizaje*. Barcelona: Narcea.
- Castells, M. (1999). *La Era de la Información I. La Sociedad Red*. Madrid, Alianza.
- Cathalifaud, A. (2014). La Construcción del Conocimiento Fundamentos Epistemológicos del Constructivismo. *Investigaciones Sociales*, 8(12), 271-287.
- Colom, A.J. (2005). Teoría del Caos & Práctica Educativa. *Revista Galega do Ensino*, 13(47). Recovered from <http://dialnet.unirioja.es/descarga/articulo/2554834.pdf>
- Downes, S. (2005). Feature: E-learning 2.0. *Elearn Magazine*, 2005 (10), 1.
- Downes, S. (2008). *Connectivism and its Critics: What Connectivism is Not*. Recovered from <http://www.downes.ca/post/53657>
- Downes, S. (2012) *Connectivism and Connective Knowledge. Essays on meaning and learning networks*. Recovered from http://www.downes.ca/files/Connective_Knowledge-19May2012.pdf
- Downes, S. (2013). The Role of Open Educational Resources in Personal Learning. *Open educational resources: Innovation, research and practice*, 207. Recovered from http://www.academia.edu/download/31833499/pub_PS_OER-IRP_web.pdf
- Duffy, T. M., & Jonassen, D. H. (Eds.). (2013). *Constructivism and the Technology of Instruction: A Conversation*. New York: Routledge.
- 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* (pp. 3-21). IOS Press, Amsterdam.
- Forster, T. (2007). *What Connectivism Is*. Urban: University of Manitoba.

- Freud, S. (1953). The Interpretation of Dreams. In *The Standard Edition of the Complete Psychological Works of Sigmund Freud*, Volume IV (1900): The Interpretation of Dreams (First Part) (pp. IX-627).
- Freud, S., & Breuer, J. (1996). In *Obras Psicológicas Completas de Sigmund Freud*. Estudios sobre la Histeria (1895). Imago: Rio de Janeiro.
- Gagné, R. (1971). *Las Condiciones del Aprendizaje*. Madrid: Aguilar.
- Harasim, L. M. (Ed.). (1995). *Learning Networks: A Field Guide to Teaching and Learning Online*. Cambridge: MIT Press.
- Holland, J. H. (1996). *Hidden Order: How Adaptation Builds Complexity*. Cambridge: MIT Press.
- Hug, T. (2005). Micro Learning and Narration. In *Fourth Media in Transition Conference*, May (pp. 6-8). Cambridge: MIT Press.
- Hug, T. (2007). *Didactics of Microlearning*. Münster: Waxmann Verlag.
- Kop, R., & Hill, A. (2008). Connectivism: Learning Theory of the Future or Vestige of the Past? *The International Review of Research in Open and Distributed Learning*, 9(3). Recovered from <http://www.irrodl.org/index.php/irrodl/article/view/523>
- Latour, B (1999). On Recalling ANT. In J. Law and J. Hassard (eds.), *Actor Network Theory and After* (pp. 15-26). Oxford: Blackwell Publishers,.
- Laurillard, D. (1993). Rethinking University Teaching: A Framework for the Effective Use of Educational Technology. New York: Routledge.
- Laurillard, D. (1999). A Conversational Framework for Individual Learning Applied to the Learning. *Systems Research and Behavioural Science*. 16(2), 113-122.
- Law, J. (1999). After ANT: Complexity, Naming and Topology. In J. Law and J. Hassard (eds.), *Actor-Network Theory and After*. Oxford: Blackwell Publishers. Oxford: Blackwell Publishers.
- Levin, S.A. (2002). Complex Adaptive Systems: Exploring the Known, the Unknown and the Unknowable. *Bulletin of the American Mathematical Society* 40(1) pp. 3-9.
- Lewin, K. (1938). The Conceptual Representation and Measurement of Psychological Forces. *Contribution of Psychological Theories*, 1(4). 19-31
- Lozares, C. (2005). Bases Sociometodológicas para el Análisis de Redes Sociales, *ARS. Empiria: Revista de Metodología de Ciencias Sociales*, 10, 9-36.
- Masie, E. (2006). Nano-Learning: Miniaturization of Design. *Chief Learning Officer*, 5(1), 17.
- Mayer, R.E. (1992). Cognition and Instruction: Their Historic Meeting within Educational Psychology. *Journal of Educational Psychology*, 84, 405-412.

- Martín, T. Y., García Rueda, J. J., & Ramirez Velarde, R. V. (2004). *Aplicaciones de la Teoría de la Conversación a Entornos Docentes Telemáticos*. Barcelona: T. Yousef.
- McLoughlin, C., & Lee, M. J. (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* (pp. 664-675). Singapur: Ascilite.
- McLoughlin, C., & Lee, M. J. (2008). Future Learning Landscapes: Transforming Pedagogy through Social Software. *Innovate: Journal of Online Education*, 4(5), 5.
- Moreno, J. L. (1962). *Fundamentos de la Sociometría*, Buenos Aires, Piados.
- Mukamel, R.; Ekstrom, A.D.; Kaplan, J.; Iacoboni, M. & Fried, I. (2010). Single-Neuron Responses in Humans During Execution and Observation of Actions. *Current Biology* 20(8), 750-6. doi: 10.1016/j.cub.2010.02.045..
- Papert, S. (1995): *La Máquina de los Niños. Replantarse la Educación en la Era de los Ordenadores*. Barcelona: Paidós.
- Organista-Sandoval, J., McAnally-Salas, L., & Lavigne, G. (2013). El Teléfono Inteligente (Smartphone) como Herramienta Pedagógica. *Revista Apertura Electrónica*, 5(1), 78-91.
- Pask, G. (1975). *Conversation, Cognition and Learning*. North-Holland: Amsterdam.
- Piaget, J. (1954). *The Construction of Reality in the Child*. New York: Routledge.
- Polsani, P. R. (2003). *Network Learning*. Recovered from http://asset.wou.edu/wp-content/uploads/2012/09/Polsani-Network-Learning_gz.pdf
- 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.
- Santamaría, F. (2010). *La Era Conectiva: por el Desorden Natural de los Artefactos & Nodos*. Recovered from <http://www.nodosele.com/editorial/wp-content/uploads/2010/01/Introduccion.FernandoSantamaria.Conociendoelconocimiento2.pdf>
- Santamaría, F. (2013). Identidad Personal e Identidad Visual en Redes Sociales y Comunidades Virtuales. *Cibermedios*, 5. 70-83
- 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*. Recovered from Lulu.com.

- Siemens, G. (2012). *MOOCs are Really a Platform*. *Elearnspace*, July, 25.
Recovered from <https://personal.psu.edu>
- Siemens, G. (2013). *What Are MOOCs doing to the Open Education?*
Recovered from <http://auspace.athabasca.ca/handle/2149/3390>
- Verhagen, P. (2006). Connectivism: A New Learning Theory. *Surf e-Learning Themaside*, 11 Recovered from <http://www.sciepub.com>
- Vygotsky, L. (1932). *El Desarrollo de los Procesos Psicológicos Superiores*. México: Grijalbo.
- Vygotsky, L. (1978). *Mind in Society*. Cambridge: Harvard University Press.
- Wertheimer, M., & Riezler, K. (1944). Gestalt Theory. *Social Research*, 81, 78-99.
- Wertsch, J.V. (1988). *Vygotsky y la Formación Social de la Mente*. Barcelona: Paidós.
- Zapata-Ros, M. (2012). Teorías y Modelos sobre el Aprendizaje en Entornos Conectados & Ubicuos. Bases para un Nuevo Modelo Teórico a partir de una Visión Crítica del “Conectivismo”. Recovered from http://elis.da.ulcc.ac.uk/17463/1/bases_teoricas.pdf



© 2018 Roberto Sánchez Cabrero and Óscar Costa Román; licensee International Journal of Educational Excellence, Universidad Metropolitana (SUAGM). This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited.