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Constructivism and connectivism in education technology: Active, situated, authentic, experiential, and anchored learning

El constructivismo y el conectivismo en tecnología educativa: El aprendizaje activo, situado, auténtico, experiencial y anclado

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Abstract

The main objectives of this theoretical paper are to compare some constructivist-related learning theories and explore how they can be adequately used in educational technology and distance education. After a brief introduction, constructivism is defined as a general philosophy of education encompassing several different learning theories. The article then presents and discusses the following theories: situated cognition, activity theory, experiential learning, anchored instruction, and authentic learning. Connectivism or distributed learning is also presented as a new and important theory, including its pedagogical view and practice in massive open online courses (MOOCs). These theories are then organized in a coherent way, classified under the constructivist umbrella, pointing their common and distinctive features. Connectivism is positioned as a new philosophy of education for the digital age, making Vygotsky's concept of zone of proximal development (ZPD) more flexible and stretching it to include learning that lies outside the learner, in social networks and technological tools. The text finally proposes further work on how these theories can be properly combined and used as frameworks for constructivist projects and activities in the fields of educational technology and distance education. The article is based on the search and review of peer-reviewed articles on constructivism, connectivism, the other aforementioned theories, and education technology and distance education.

Keywords: learning; cognition; educational technology; distance education.

Resumen

Este artículo teórico pretende comparar algunas teorías de aprendizaje relacionadas con el constructivismo y explorar cómo pueden usarse adecuadamente en el campo de la tecnología educativa y la educación a distancia. Después de una breve introducción, el constructivismo queda definido como una filosofía general de la educación que abarca varias teorías de aprendizaje diferentes. El artículo presenta y analiza las siguientes teorías: cognición situada,

teoría de la actividad, aprendizaje experiencial, instrucción anclada y aprendizaje auténtico. El conectivismo o aprendizaje distribuido también se presenta como una nueva e importante teoría, que incluye su visión pedagógica y práctica en cursos masivos y abiertos en línea (MOOCs). Organizamos estas teorías de manera coherente bajo el paraguas constructivista e indicamos las principales similitudes y diferencias entre ellas. El conectivismo se posiciona como una nueva filosofía de la educación para la era digital, flexibilizando y ampliando el concepto de Zona de Desarrollo Próximo (ZDP) de Vygotsky para incluir el aprendizaje que se encuentra fuera del alumno, en redes sociales y herramientas tecnológicas. El texto finalmente propone un trabajo adicional sobre cómo estas teorías pueden combinarse y utilizarse adecuadamente como marcos para proyectos y actividades constructivistas en los campos de la tecnología educativa y la educación a distancia. El artículo se basa en la investigación y revisión de artículos revisados por pares sobre el constructivismo, el conectivismo, las otras teorías mencionadas y la tecnología educativa y la educación a distancia.

Palabras clave: aprendizaje; cognición; tecnología de la educación; educación a distancia.

The purpose of this article is to discuss and help to understand how constructivist-related theories on learning can be properly used in the fields of educational technology and distance education.

The Web 2.0 movement and new tools such as blogs and microblogs, wikis, podcasting, social bookmarking and social networking contributed to replace passive teaching methodologies by more active ones including student-centred learning, the co-creation of knowledge, and peer review assessment strategies. Siemens (2008), for instance, argues that technological development and social software significantly alter the way learners access information and knowledge and interact with their instructors and peers. Dron and Anderson (2014) list some of the major pedagogical contributions of social software: it helps build communities and create knowledge; engages, motivates and is enjoyable; is cost-effective; is accountable and transparent; spans the gap between formal and informal learning; addresses both individual and social needs; builds identity, expertise, and social capital; is easy to use; is accessible; protects and advances current models of ownership and identity; is persistent and findable; supports multiple media formats; encourages debate, cognitive conflict, and discussion; leads to emergence; is soft; supports creativity; and expands the adjacent possible (new paths for changes opened up by new technologies).

In this article, the following specific theories are discussed: situated cognition, activity theory, experiential learning, anchored instruction, authentic learning and connectivism. The hypothesis is that they are subtypes of constructivist approaches to teaching and learning. The text explores and organizes these theories under the constructivism umbrella, comparing and pointing their common and distinctive features.

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After explaining the methodology, the article presents the results of the review for each of these theories, discussing then the findings in a comparative way and concluding with suggestions for further work.

METHODOLOGY

The research involved a literature review following Okoli's (2015) guidelines and including the following steps: identifying the purpose of the review; protocol drafting and team training; applying practical screens; search for literature; data extraction; quality appraisal; synthesizing studies and writing the review.

The review, intended to characterize and differentiate the aforementioned theories, was performed individually by the author. Google Scholar, Web of Science, and Scopus were used as databases for the searches, and the names of the theories themselves for the queries: "constructivism" OR "connectivism" OR "educational technology" OR "education technology" OR "activity theory" OR "situated learning" OR "authentic learning" OR "experiential learning" OR "anchored learning".

Owing to the large number of results obtained, its relevance and the number of citations of the papers were used as practical screening inclusion criteria. Texts in English, Spanish, and Portuguese were read and a preference was given to theoretical articles published in peer-review journals in the fields of educational technology and distance education. The distribution of texts by journal in this initial search is showed in the following table:

Table 1. The distribution of texts by journal

The International Review of Research in Open and Distributed Learning	3
Educational Researcher	2
Educational Technology & Society	2
American Psychologist	1
Design and Technology Education: An International Journal	1
Educational Technology	1
Journal of Asynchronous Learning Networks	1
Journal of Authentic Learning	1
Journal of Computer Assisted Learning	1
Journal of Educational Technology & Society	1
Journal of Technology Education	1
Open Praxis	1
Radical Pedagogy	1

These initial research results were expanded using different techniques: backward search (searching for quoted texts and theoretical references by these articles, including papers, chapters, articles, dissertations, and theses); search for articles published by the same authors; and forward search (texts that cited these initial articles). Milestone referenced works on the selected articles and references that explored similar objectives to this research were also read.

Data extraction involved the main aspects of each of the theories and its relationships to constructivism, educational technology, and distance education. Content analysis (Bardin, 2013) was used as technique for coding, analyzing, and synthesizing the texts, with categories constructed *a posteriori* to the readings. No software was used for this coding and categorization. A brief text was then written for each theory with a final comparison and summary of its main points.

RESULTS

The results are presented taking constructivism as an umbrella for the analyzed learning theories. Connectivism is treated as a separate theory, although in some points it is based on constructivism.

Constructivism

Associated with the works of main authors such as Lev Vygotsky, John Dewey, and Jean Piaget, constructivism can be considered a major theory of learning, and in a broader sense a philosophy of education, used as a general title to classify several other theories. There is then a need to define what we mean by *constructivism* to adequately found our work in education, more specifically in the fields of educational technology and distance education.

In an important theoretical work, Kanuka and Anderson (1999) try to organize a scheme of constructivist learning theories, criticizing the systematic aspect of instructionism, which does not correspond to the way we learn. Educators should use the time to understand the real and actual interests of learners and, based on this information, incorporate learning activities that have real relevance for each learner. Instructivism, on the other hand, distances us from critical thinking with its proposal to follow models of instructional systems design, though freeing us from confronting the complexity of the world where we must act, which is problematic, ambiguous, and constantly changing.

The authors also review the main constructivist theories that influenced learning mediated by technology, trying to organize them in two dimensions: the understanding of reality as objective/subjective and the design of knowledge as social/individual. The combination of these two continua result in four types of constructivism: (1) cognitive constructivism, (2) radical constructivism, (3) situated constructivism, and

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(4) co-constructivism. Despite the differences among these four views, the authors argue that they share common beliefs: learning is active, not passive; language is an important element in the learning process; and learning environments should be focused on the learner. The focus of education according to constructivism is not on content but process, so educators need to know their learners to organize this process. Much later, Anderson (2016) points out that all forms of constructivist theories "share the understanding that individuals' construction of knowledge is dependent upon individual and collective understandings, backgrounds, and proclivities" (p. 38).

Tam (2000) relates constructivism, the construction of technology-supported learning environments and the practice of distance education. Distance learning provides a unique context to infuse constructivist principles, where learners are expected to function as self-motivated, self-directed, interactive, and collaborative participants in their learning experiences. The author explores how constructivism theory and education technology can combine to transform distance learning from a highly industrialized mass production model to one that emphasizes subjective construction of knowledge and meaning derived from individual experiences.

Constructivist theories

Several learning theories are usually classified as constructivists. This section presents and differentiates some of these theories that are often used as synonyms: situated cognition, activity theory, experiential learning, anchored instruction, and authentic learning. Connectivism is also presented as a new and important theory somehow linked to constructivism.

Situated cognition

Situated cognition emphasizes the importance of context and interaction in the process of knowledge construction. Jean Lave's *Cognition in Practice* (1988) is generally considered a founding reference for the theory.

Greeno (1989) argues that thinking is situated in physical and social contexts, so cognition (including thinking, knowing, and learning) should be considered a relation in a situation, rather than an activity in an individual's mind. Thinking involves individuals' constructive and cognitive interactions with objects and structures of situations, rather than simply processes and manipulations of symbols that occur in the minds of individuals, as many information-processing models propose. Knowing is a product of the students' individual and social intellectual activity, so teachers should create social settings to support this production.

Brown, Collins, and Duguid (1989) argue that knowledge, learning, and cognition are fundamentally situated in activity, context, culture, and situations.

Knowledge indexes the situation in which it arises and in which it is used, and learning is a process of enculturation, partly supported through social interaction. Representations arising out of activity cannot be easily replaced by descriptions: problems do not come in textbooks, so learning methods should be embedded in authentic situations. As an alternative to conventional schooling practices, these authors propose "cognitive apprenticeship", which tries to enculturate students into authentic practices through activity and social interaction, like craft apprenticeship.

Clancey (1994) argues that the world is not given as objective forms, pre-represented; on the contrary, what we perceive as properties and events is constructed in the context of activity. Representational forms are given meaning and constructed in a perceptual process, which involves interacting with the environment and creating information. The author studies how interpersonal and gestural-material processes change attention, what is perceived, and what is represented. Human memory is not a place where linguistic descriptions are stored, but they are created, given meaning and influence behavior through interactions. In equating human knowledge with descriptions, we oversimplified the complex processes of coordinating perception and action, objectifying what is an interactive and subjective process. The author proposes a shift from the individualist point of view of linguistic models, which take what goes on inside the head of a person to be the locus of control, to interactions between people and between internal and external processes. Instructional design based on the constructive nature of learning should consider these interpersonal and gestural-material aspects of perception. In this sense, situated cognition provides a new way of integrating instructional ideas.

Wilson and Myers (2000) explore situated cognition (SitCog) and situated learning. Not only does SitCog mean concrete learning, but it also emphasizes the network of social systems and activities in which the authentic practice evolves. While the theory of symbolic processing focuses on neural mechanisms and symbolic representations of the mind, SitCog focuses on the structures of the world and how they determine and guide behavior. Knowledge, learning, and cognition are social constructions expressed in actions of people interacting in the communities. The article remarks that the field of study is vast and varied, including both (1) social, cultural, and historical perspectives based on Vygotsky (as the anthropologists Jean Lave and Lucy Suchman), interested in the cultural construction of meaning; and (2) cognitive scientists (such as Allan Collins, John Seeley, Don Norman, and Bill Clancey), interested in cognition at the individual and social levels, based on theories of artificial intelligence, psychology, and linguistics. The general feature of situated cognition is the positioning of individual cognition in a broader physical and social context of interactions, tools, and culturally constructed meanings, as the construction of meaning is a social activity. Design should though be seen more in terms of interaction and less in terms of rational planning, and design theories should be chosen according to the learning situation.

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A more theoretical approach is developed by Hung, Looi, and Koh (2004), in which they revisit the foundations of situated cognition relating it to the work of the German philosopher Martin Heidegger and the interest in communities of practice (Lave & Wenger, 1991; Wenger, 1998).

Active learning

The activity theory emphasizes the importance of learner engagement and action to support the learning process. Learning is considered an active construction process, inseparable from doing, and a reflection about what learners are doing, not a passive reception of knowledge.

Jonassen (2000) explores the use of the activity theory for the design of learner-centered learning environments. The activity theory is defined as a philosophical framework, based on the ideas of the German philosophers Immanuel Kant, Georg Hegel, and Karl Marx and the Russians Lev Vygotsky, Alexander Luria and Alexei Leontev. Activity and conscious learning are dynamically interrelated and cannot be separated. Therefore, it would be important to examine the activity systems (structures of activities in their sociocultural and sociohistorical contexts) as part of the process of instructional design. These systems are composed of individuals, tools, objects, division of labor, community, and rules, all involved in mutual interactions. In the design process, though, the concepts, rules, and theories that are not associated with action have no meaning. There is no sense, therefore, to simply slice content or decompose knowledge out of context, as proposed by many models of instructional design.

During the last years, several active methodologies have been developed and stressed both for face-to-face and online learning: blended learning (Horn & Staker, 2014), flipped classroom (Bergmann & Sams, 2012), peer instruction (Crouch & Mazur, 2001), case method (Kasloff, 2011), problem-based learning (*Interdisciplinary Journal of Problem-based Learning* — IJPBL and *The Journal of Problem Based Learning in Higher Education* — JPBLHE), project-based learning (Bender, 2012), game-based learning (Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012), gamification (Landers, 2014), and design thinking (Scheer, Noweski, & Meinel, 2012; Koh, Chai, Benjamin, & Hong, 2015). *Active learning* can though be considered an umbrella expression for several theories and practices, whose principles are distributed through all the theories studied in this article.

Experiential learning

Experiential learning emphasizes the importance of experience in constructing knowledge. Two works by Kolb (1984, 1993) are usually mentioned as references for the concept, although John Dewey's notion of *experience* and Malcom Knowles'

andragogy are also foundational. Real-life and practice-based experiences in authentic workplaces are considered drives for relevant teaching and learning.

Hansen (2000) explores how the discursive and non-discursive worlds blend in education and how to balance factual and practical knowledge adding experience as a central ingredient. As he concludes:

> making experience a central element in school curriculum would mean that writing curriculum would change dramatically. Learning outcomes would likely be more difficult to articulate. Their achievement by students would be less controlled and less controllable. In the context of increasing teacher accountability, reducing teacher control on a system-wide basis could be a recipe for disorder if not chaos. On the other hand, interests outside of and inside the schooling infrastructure are calling for greater relevance in the curriculum and an experiential curriculum could be the answer (p. 30).

Beckem and Watkins (2012) show how simulations might provide valuable experiential and authentic student-centred practices, increasing student engagement and promoting deeper learning.

Anchored learning

For the Cognition and Technology Group at Vanderbilt (1990), who coined the expression, anchored learning is related to situated cognition, authentic learning, and experiential learning, some of the other theories studied in this article. The theoretical and empirical background of anchored instruction goes back to Whitehead's (1929) inert knowledge problem ("knowledge that can usually be recalled when people are explicitly asked to but is not used spontaneously in problem solving even though it is relevant", p. 2) and Dewey's (1933) concept of knowledge as a tool.

Anchored instruction aims to overcome the problem of inert knowledge through immersion: as "novices have not been immersed in the phenomena being investigated, they are unable to experience the effects of the new information on their own noticing and understanding" (Cognition and Technology Group at Vanderbilt, p. 3). The group anchors instruction in complex problem-solving environments, called macro contexts, which enable the exploration of a problem for extended periods of time from many perspectives, serving as environments for cooperative learning and teacher-directed mediation. Concepts that explore the relationships between anchored instruction and situated cognition include cognitive apprenticeship and authentic tasks (Brown et al., 1989), with the suggestion of transforming school instruction into apprenticeships. Anchors should provide opportunities for teacher-guided discovery. The Cognition and Technology Group at Vanderbilt (1993) revisited the concept; other articles were later published, as well as a book (1997).

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Young and Kulikowich (1992) define anchored instruction as teaching through situations. Several references already mentioned about the benefits of teaching in a complex realistic context are presented: Whitehead's *The Aims of Education and other essays* (1929), Dewey's *Experience and education* (1938), Lave's *Cognition in practice* (1988), and the concept of cognitive apprenticeship (Brown et al., 1989). Situated cognition states that not only learning, but all thinking is situated (Clancey, 1994; Greeno, 1989). Situated learning is analyzed by the authors from an ecological perspective and they develop the idea of anchored assessment to assess situated learning. The goal of situated learning is defined as cross-situational transfer.

The transfer of learning in anchored instruction can also involve knowledge abstraction strategies, in which knowledge is decontextualized from the learning situation.

Authentic learning

Authentic learning emphasizes that learning contexts, tasks, activities, and assessment should be the most authentic possible to support the transfer of knowledge from formal education to practice. Reeves, Herrington, and Oliver (2002) present ten characteristics of authentic activities which they apply to online learning:

1. Authentic activities have real-world relevance.
2. Authentic activities are ill-defined, requiring students to define the tasks and sub-tasks needed to complete the activity.
3. Authentic activities comprise complex tasks to be investigated by students over a sustained period of time.
4. Authentic activities provide the opportunity for students to examine the task from different perspectives, using a variety of resources
5. Authentic activities provide the opportunity to collaborate.
6. Authentic activities provide the opportunity to reflect.
7. Authentic activities can be integrated and applied across different subject areas and lead beyond domain-specific outcomes.
8. Authentic activities are seamlessly integrated with assessment.
9. Authentic activities create polished products valuable in their own right rather than as preparation for something else.
10. Authentic activities allow competing solutions and diversity of outcome.

Our research, however, did not identify authentic learning as a separate and sound theory with founding authors and works such as the other ones analyzed, but instead as a general principle present in the other theories studied. As Maina (2004) states, authentic learning "involves increasing motivation and enthusiasm, helping learners to make decisions concerning their learning, as well as identifying non-traditional ways learning is enhanced and accounting for such learning" (p. 7).

Connectivism

Although some authors argue that connectivism should not be considered a new theory of learning and/or question its fundamentals (Kerr, 2007; Kop & Hill, 2008; Kop, 2011; Bell, 2011; Clarà & Barberà, 2014), it is possible to position it as the development of constructivism in response to the current scenario of the intense use of technology in education, functioning though as a philosophy of education. Anderson and Don (2011, 2012), for instance, place it as the third generation of pedagogy of distance education, following behaviorism/cognitivism and social-constructivism, associating each one to different technologies, instructional designs, and educational activities.

In his classical article, Siemens (2004) discusses the limitations of behaviorism, cognitivism, and constructivism as theories of learning because they would not address learning that occurs outside people (i.e. learning that is stored and manipulated by technology) and within organizations. Connectivism or distributed learning is then proposed as a more adequate theory for a digital age, when action is needed without personal learning, using information outside our primary knowledge. Learning theories should be adjusted in an age in which knowledge is no longer acquired in linear manner, technology executes many of the cognitive operations previously performed by learners (information storage and retrieval), and in many moments performance is needed in the absence of complete understanding. Learning is no longer a process that is entirely under the control of the individual, an internal, individualistic activity: it is also outside ourselves, within other people, an organization or a database, and these external connections which potentiate what we can learn are more important than our current state of knowing.

Cognition and learning are distributed not only among people, but also among artifacts, as we can offload some cognitive work to devices that are more efficient at performing tasks than humans. This can either happen naturally in the learning process or be used as an instructional strategy, for example for designing distributed learning environments. In this new scenario, Siemens (2008) builds four metaphors for the educator: master artist, network administrator, concierge, and curator.

Massive open online courses (MOOCs) are one of the important outputs of connectivism, although the Coursera-style courses (xMOOCs) vary significantly fromthe initial MOOCs proposed by George Siemens and Stephen Downes (cMOOCs) (Siemens, 2012), with rhizomatic learning MOOCs (with no centre, no content, nor assessment: the community being the curriculum) positioned on the extreme "c" of the spectrum (Mackness & Bell, 2015). However, negative results are also reported related to connectivist-style MOOCs. Kop (2011), for instance, researched the Personal Learning Environments, Networks, and Knowledge (PLENK2010) MOOC, facilitated by George Siemens, Stephen Downes, Dave Cormier, and Rita Kop with 1,610 participants. The results showed that not all students were able to autonomously direct their own learning and master critical literacies, such as the

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creation and distribution of digital artifacts and the use of several tools, to properly learn in a changing and complex learning environment missing organized guidance and the social presence of facilitators and participants. Mackness and Bell (2015) researched Rhizomatic Learning: The Community is the Curriculum (Rhizo14), led by Dave Cormier in January/February 2014 with more than 500 participants. Although many students experienced the light side of the course, some had mixed feelings and experiences, while some even felt disconnected, demotivated, demoralized, disenfranchised, and disturbed — the dark side. It seems, though, that there is a challenge to connectivism to scale up as a theory for networked learning, one of its objectives.

DISCUSSION

The results of this research show a strong similarity between situated cognition and anchored learning. Both emphasize the importance of context for learning and refer to Jean Lave's founding work *Cognition in practice* (1988), John Dewey's ideas, and the concept of cognitive apprenticeship (Brown et al., 1989). Although several authors have contributed to the concept of situated cognition, the Cognition and Technology Group at Vanderbilt is responsible for the development of the concept of anchored learning. A specific and systematic comparison of these two theories, though, seems to be a valuable research direction for the fields of educational technology and distance education.

Experiential learning, although briefly explored in this article, deserves a place in the list of constructivist theories both because of the founding works of Kolb (1984, 1993) and the positioning of experience as a central element in education, what differentiates it from the other theories analyzed.

Activity theory and active learning, as noted, can be more adequately classified as a philosophical framework, entailing principles that can be found in all the theories studied in this article. As Kanuka and Anderson (1999) state, "learning is active" is a common belief of different constructivist views. Authentic learning, in turn, is not linked to any founding authors or works and involves principles that are also part of all the other constructivist theories analyzed.

Connectivism deserves a more careful discussion. Although Siemens (2004) advocates that it is a new learning theory (more adequate then behaviorism, cognitivism, and constructivism for a digital age), Anderson and Don (2011, 2012) position it as a pedagogy of distance education following behaviorism/cognitivism and social-constructivism, that is to say, an updated version of a philosophy of education, in the terms we have defined constructivism in this article. But there is at least a specific point that contributes to differentiate these two general approaches.

Vygotsky's (1978) concept of *zone of proximal development* (ZPD) signalizes "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through

problem solving under adult guidance or in collaboration with more capable peers" (p. 86), that is to say, a virtual space between (a) what a learner can know/do working alone and (b) what the learner can know/do supported by a teacher or a more experienced peer. We could even say that there is still a previous stage where the learner knows/can do things without working at all (–a) and a zone where the learner can´t know/work even when guided, because, for instance, he or she is still not psychologically mature or technically prepared (b+).

Connectivism somehow subverts this hierarchy (–a, a, b, b+) and even blows these limits. Digital technologies contribute to a collaborative epistemology in which learning is constructed by a group, not only by an individual anymore, even when interacting with others. Learning is now negotiated through these interactions, it is a networked activity and construction.

Social software and media are then the drives for network-directed learning, moving beyond self-directed learning. In this sense, Siemens (2011) criticizes the concept of autonomy: self-directed learning, in which learners learn in their own pace and interest, would not be sufficient to describe our knowledge needs today:

> When faced with learning in complex environments, what we need is something more like network-directed learning – learning that is shaped, influenced, and directed by how we are connected to others. Instead of sensemaking in isolation, we rely on social, technological, and informational networks to direct our activities.

Besides, as Siemens (2004) states, "know-how and know-what is being supplemented with know-where (the understanding of where to find knowledge needed)". We do not need to learn (and internalize) how or what to do, but we need to know where to find knowledge (outside ourselves) to support our actions in certain situations. Social software and media though support not only social interactions, but also active learning.

That is to say, the support for the learner through the ZPD can today be appropriately exercised both by tools (learning occurs outside people) and by group collaboration, where sometimes the learner is learning, sometimes teaching, and this collaboration constructs the group's knowledge, not only individual knowledge.

But it is still possible to advance in the comparison: we can say that connectivism reformats Vygotsky's ZPD. Initially, it proposes that learning can occur outside people, for example stored and manipulated by technological tools. In this sense, it ceases to be an internal process, an individualistic activity. Besides, a user can "learn" something (or how to do something) by activating these tools, which perform the task of the adult or a more capable peer, but then forget that knowledge — because they do not need it anymore, while the learning continues to rest outside the person, stored and manipulated by external artifacts. The person gets back to the position of not knowing, so the ZPD starting point (a) is, after the action is concluded, reconstructed backwards — we have now a flexible zone! Technology "teaches" the

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learner, making them capable of knowing (or knowing how), but that knowledge is then lost — although it can be retrieved and activated again whenever needed. We can then say that the digital age has reconfigured ZPD to a heart zone, which stretches and retracts according to the learner's interest — but an external heart, an accordion, for it is not anymore an individual internal virtual space, but an external collaborative virtual group: an artificial intelligence heart.

There is though no more need to conceive a totally controlled, internal, and individual ZPD: cognition and learning are distributed not only among people, but also among artifacts. In this sense, we can say that connectivism is an updated version of the constructivist philosophy of education for a digital age.

CONCLUSION AND FURTHER WORK

Our theoretical journey explored the main aspects of theories generally classified as constructivists and the main ideas they propose: (a) situated cognition (context and interaction are essential in learning) and anchored instruction (education through immersion in authentic contexts) and (b) experiential learning (experience should be used strategically in education). Authentic learning (learning needs authentic contexts, tasks, activities, and assessment to support knowledge transfer) and activity theory (learning is an active construction) were not considered theories, but general features of these other constructivist theories.

One of the contributions of this article is a new perspective on Vygotsky's concept of zone of proximal development (ZPD) through the lens of connectivism. ZPD can now be conceived as a group and network activity, not only as something that happens in the mind of an individual learner. Instead of being directed by a more experienced peer, learning can now be conceived as a network-directed activity. Besides, the ZPD path can now be actively supported by tools (or educational technologies), not only people. And the zone can even be considered flexible, in the sense that networks and technologies allow it to expand and retract, according to the learner's immediate needs.

Although the article explored uses of these theories in educational technology and distance education, further work is needed to determine if they can be coherently grouped as a specific set of constructivist theories and if they can serve as a theoretical framework for educational technology and distance education projects and activities. Karagiorgi and Symeou (2005), for example, explore how constructivism supports instructional design, paying specific attention to authentic learning, active learning, situated cognition, and anchored instruction.

The article proposes that connectivism or distributed learning should be considered an updated version of constructivism, understood as a general philosophy of education for the digital age. In this sense, further work is necessary to determine if (and how) connectivism can function, as constructivism does, as a general title for theories such as situated cognition, anchored instruction, and experiential learning,

or if it does not encompass the main aspects of these theories. Further work is also needed to explore the application of connectivism in educational technology and distance education. Of specific interest is the development of reflection on the reconfiguration of Vygotsky's zone of proximal development and its potential uses in education.

Tendencies such as virtual and augmented reality, artificial intelligence, machine learning, semantic web, internet of things, and learning analytics should play a role in the future research and practice of educational methodologies and technologies, particularly in distance education. In this sense, we must reflect if the theories studied in this article can serve as background for these practices or if we need to produce new theories for that purpose.

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