Connected active learning amidst the chaos of the student-actor-network

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Abstract: This article brings a reflection on education in communication. Top-down models are being debated and have not been used since the internet. Teachers and students discover and update knowledge in real time, within and outside the classroom – in chats, on the streets, on WhatsApp – and share knowledge by creating links. Here are just two of the basic principles of this study: Connectivism, postulated by Siemens (2005): maintaining up-to-date and rigorous knowledge is the goal of all collectivist learning activities and learning can reside in non-human devices. His theory takes into account the tendencies of learning, the use of technology and networks. It also emphasizes the reduction of the half-life of knowledge. Thus, one of the proposals was to compare Siemens' theory to the work of authors such as Downes, Brown, Santaella, Mattar, Perniola and Latour, among others, who inspire us to apply actions, transcriptions and interactions with students in our daily lives, in order to collaborate to this reflection.

Keywords: connectivism; actor-network theory; social technology; active learning; interaction.

Resumo: Este artigo traz uma reflexão sobre educação na comunicação. Modelos top-down são postos em discussão e em paulatino desuso desde a chegada da internet. Professores, junto dos alunos, descobrem e atualizam o conhecimento em tempo real, na sala de aula e fora dela – nos chats, nas ruas, no WhatsApp – e compartilham saberes criando laços. Eis apenas dois dos princípios da base deste estudo, o conectivismo, postulado por Siemens (2005): a manutenção de um conhecimento atualizado e rigoroso é o objetivo de todas as atividades de aprendizagem coletivistas; e o fato de que a aprendizagem pode residir em dispositivos não humanos. Conforme sua teoria, além de levar em conta as tendências da aprendizagem, o uso da tecnologia e das redes enfatiza a diminuição da meia-vida do conhecimento. Assim, uma das propostas foi cruzar o pensamento de Siemens com autores como Downes, Brown, Santaella, Mattar, Perniola e Latour, que nos inspiram a aplicar no dia a dia as ações, transcrições, interações com os estudantes de modo a colaborar nesta reflexão.

Palavras-chave: conectivismo; teoria ator-rede; tecnologia social; aprendizagem ativa; interação.

35

Chaos, understood as science, acknowledges the connection between all and everything, as stated by George Siemens[1] when emphasizing the inclusion of all to everything. "In weather, for example, this translates into what is only half-jokingly known as the Butterfly Effect – the notion that a butterfly stirring the air today in Peking can transform storm systems next month in New York"[2]. This analogy serves to highlight a real challenge: in what way does the "sensitive dependence on initial conditions" affect so deeply what we learn and how we act based on our learning.

> While most traditional science deals with supposedly predictable phenomena like gravity, electricity, or chemical reactions, Chaos Theory deals with nonlinear things that are effectively impossible to predict or control, like turbulence, weather, the stock market, our brain states, and so on. These phenomena are often described by fractal mathematics, which captures the infinite complexity of nature. One of the principles of Chaos is unpredictability, because we can never know all the initial conditions of a complex system in sufficient (i.e. perfect) detail, we cannot hope to predict the ultimate fate of a complex system. Even slight errors in measuring the state of a system will be amplified dramatically, rendering any prediction useless[3].

Linearity cannot be the foundation for the education system in the era of information. At this stage, it is essential to build models with a nonlinear format to facilitate learning. After all, learning and thinking are not linear processes; thus, it is possible to apply the chaos theory to complex systems of today, like schools, which provide a clear opportunity to change and transform[4].

Decision making is indicative of that and depends on its own conditions. "If the underlying conditions used to make decisions change, the decision itself is not as correct as it was at the time it was made. The ability to recognize and adjust to pattern changes is a key task of learning"[5].

Top-down models (impositions that follow the hierarchy from lowest to highest) are being discussed and gradually underused since the arrival of the internet (free in nature – for now), which initiated interaction through message exchange precisely between scholars. Teachers, alongside students, discover, enhance and renew knowledge as it happens in the classroom and beyond it – in chats in the web, meetings on the streets, conversations in WhatsApp – and also share it by creating links. "Technology has reorganized the way we live, the way we communicate and learn"[6].

Mario Perniola[7] reflects on this subject when saying that alienation (a kind of isolation) "of feeling is not delegating to others what we should be the ones to feel and much less in the event of any respectable model teaching us how we should feel". The author highlights sensitivity and affectivity:

> If it were simply an obligation to feel, this structure would not be changed: the delegation could be revoked at any time and we could go back to feeling directly. In truth, nobody today seems willing to delegate the experience of what has already been felt to others, as nobody wants to be excluded from experiencing it. In relation to the presence of models that would set the tone of our times, there are no *maîtres*

1. SIEMENS, George. Connectivism: A learning theory for a digital age. **International Journal of Instructional Technology and Distance Learning**, v. 2, n. 1, 2005. Available in: <http://www.itdl.org/Journal/Jan_05/article01.htm>. Access on: Feb. 8, 2015.

2. GLEICK, 1987 apud SIEMENS, op. cit. 2005.

3. FRACTAL FOUNDATION. What is chaos theory? Available in: http://fractalfoundation.org/resources/what-is-chaos-theory/.

4. KARTAL apud AKMANSOY, Vesile; KARTAL, Sadik. Chaos theory and its reflections on education: Mehmet Akif Ersoy University case. **Educational Sciences**: Theory & Practice, v. 14, n. 2, p. 510-518, 2014.

5. SIEMENS, op. cit.

6. SIEMENS, op. cit., 2005.

7. PERNIOLA, Mario. **Do sentir**. Translated by Tom Guerreiro. Lisboa: Editorial Presença, 1999. p. 22.

à sentir to imitate: that which has already been felt cannot be imitated, but repressed, reverberated, reflected. On the horizon of alienated feelings there is no longer a place for a sentimental education that teaches little by little how to confront the inner world with effectual reality, which is in fact not rational and practical, but essentially aesthetic, impregnated and soaked in sensitivity and affectivity. Virtual reality contains all the possible scientific figures, dimensions and aspects, it is the complete map of the *pays du tendre*, which each one has nothing more to add, and can only be traversed; it is a comprehensive repertoire of sensations and affections already felt that can only be reproduced, repeated[8].

It is impossible to think everything has already been studied or that work experience is enough to believe in a single source of knowledge, the teacher. In times of fast information and experiments originated not only from written compositions (as in the case of journalism) but also from web portals and sites, networks, the blogosphere etc., instructors do not cease to learn, if they so wish.

John Seely Brown[9] presents an interesting notion that the internet promotes the small efforts of many with the great efforts of some. The central premise is that: "The connections created with unusual nodes support and intensify the existing activities of great effort. This amplification of learning, knowledge and understanding through the extension of a personal network is the epitome of connectivism"[10].

As we study George Siemens' Connectivism theory as one of the pillars of the theoretical basis of the work of this researcher, we can refer to him in this moment that corroborates the urgency of following the evolution of time in education according to the technology that surrounds and constantly modifies it. After all, connectivism is precisely a model[11] of

learning that recognizes the tectonic changes in society, where learning is no longer an internal and individualistic activity. The way people work and function is changed when new tools are used. The field of education has been slow to recognize both the impact of new learning tools and the environmental changes in what it means to learn[12].

Students increasingly have been acquiring a position of autonomy in the learning process. "In active learning, as opposed to passive learning, based on the transmission of information, the student assumes a more active role, in which he solves problems, develops projects and, with this, creates opportunities for the construction of knowledge", according to the conceptualization of Valente[13].

The theory of Connectivism seeks to detect the current needs (of the last few decades) and provides insight on how to acquire the skills needed for learning and essential tasks for students to flourish in a digital age, such as for example, the meta-competence of exploration of ways to obtain information. However, it is important to highlight what is emphasized by Mark Deuze: "It is almost impossible to deny the media activity in the hands of the individual. However, this does not mean that people are automatically literate when it comes to media, which is, of course, a challenge of technology and education"[14].

8. Ibidem.

9. Brown provides as an example a project of the *Maricopa County Community College* system that connects older adults to elementary school students in a mentoring program. The children "listen to these" grandparents "better than they do with their own parents, the guidance really helps teachers... the small efforts of many – the older adults – complement the big efforts of few – the teachers". (BROWN, John Seely. **Growing up digital:** How the Web Changes Work, Education, and the Ways People Learn. United States Distance Learning Association, 2002. Available at: <http://www.usdla.org/html/journal/FEB02_Issue/article01.html>).

10. BROWN, op. cit.

11. SIEMENS, op. cit.

12. Ibidem.

13. VALENTE, José Armando: Blended learning e as mudanças no ensino superior: a proposta da sala de aula invertida. **Educar em Revista**, Curitiba, special edition, n. 4, p. 79-97, 2014.

14. BECKER, Beatriz. Vida na mídia: além do jornalismo. Entrevista com Mark Deuze. **Revista Eco Pós**, v. 1, n. 19, 2016. Available in: <https://revistas.ufrj.br/index.php/eco_pos/article/view/3354/2629>. Access on: Nov. 12, 2016.

To face this challenge – of keeping knowledge always up-to-date – especially because according to this theory, besides taking into account the tendencies in learning, the use of technology and networks emphasizes the issue of reducing the duration of the lifetime of knowledge until it becomes obsolete, when the ability to evaluate it quickly is highly valued, here are some of the principles of Connectivism postulated:

- learning and knowledge rely on a diversity of opinions;
- learning is a process of connecting specialized nodes or information sources;
- learning may reside in non-human devices;
- the ability to know more is more important than what we know at any given moment;
- promoting and maintaining connections are essential to facilitate continuous learning. The ability to see connections between ideas, concepts and fields of knowledge is a crucial competence;
- the maintenance of an updated and rigorous knowledge is the goal of all collectivist learning activities;
- making decisions is a learning process itself. Choosing what to learn and the meaning of the information that reaches us is seen through the lens of a reality that is in constant transformation. The answer that is correct today may be wrong tomorrow due to changes in the informational climate that affects the decision.

Interactions with students, especially freshmen in undergraduate courses, are guided mostly by emotions. By studying how the brain learns, neuroeducation destroys traditional teaching methodologies. The most decisive contribution is that "emotions need to be stirred in the brain so it may learn. And there is no innovative idea considered valid that does not contain this principle"[15] – says the introduction of the interview of Menárguez with Francisco Mora, who "recommends caution and warns that in neuroeducation there are still more questions than answers"[16].

We know that the time devoted to lectures should last no more than 20 minutes[17]. Mora reinforces the premise to shorten the duration of classes, but still speaks of more than twice as long when arguing that "education can be transformed to make learning more effective, for example, reducing the time of lessons to less than 50 minutes so that students are able to maintain their focus"[18].

Neuroeducation transfers the information of how the brain works with the improvement of the learning processes. Mora claims it to be essential "to know the stimuli that draw attention, which will then give way to emotion"[19], because without these two factors, learning does not occur. It is clearly more difficult to make students learn or reflect on something if they are not motivated.

It is necessary to instigate curiosity, which is the brain mechanism capable of detecting the difference in daily monotony. Attention is paid to that which stands out, to that which is pleasurable. Stirring emotions in the student is the most

15. Mora, Ph.D. in Neuroscience by the University de Oxford and professor of Human Physiology at the Universidade Complutense de Madrid, is the author of *Neuroeducación. Solo se puede aprender aquello que se ama*. MORA, Francisco. "The 50-minute lesson format must end". Neuroeducation expert bets in the change of methodologies, but says the Neuroscience must be applied with caution in Education. Article for the newspaper **El País**, Madrid, 23 fev. 2017. Available at: <http://brasil.elpais.com/brasil/2017/02/17/economia/1487331225_284546.html>. Accessed on: Feb. 23rd, 2017.

16. Mora, op. cit.

17. Correa Lima, Manolita. Presentation at the Professors' Academy, Escola Superior de Propaganda e Marketing, São Paulo, 2016.

18. Ibidem.

19. Ibidem.

important basis by which the processes of learning and memory are supported. Emotions serve to store and recall information more effectively[20].

Teachers should start their classes in a stimulating manner; Mora even regards the use of shocking images and provocation elements as a teaching technique for sensitizing students, obviously not in the sense of (respectively) offense or insult, as is usually implied by these terms – the intention is to "break the routine and fight monotony. We know that for a student to pay attention in class, demanding him to do so is not enough"[21].

Mora believes the unknown elements, which end up surprising us, are precisely those that stimulate attention; thus, they are indispensable to the learner's experience. In another technique, he concludes with the part that is most difficult to understand in active methodologies: self-learning in challenges as a means of finding solutions. This is tricky because, in the era of speed, students are restless multi-taskers, eager to resolve and finish a task. "The brain uses all its resources each time it is faced with problem solving, with learning or memory processes"[22].

Students pay attention to content they are emotionally involved with, to subjects they are curious about and that encourage them to discover and solve challenges collectively. If there is some type of competition in game form, the better for the underlying learning process. When they play, they learn. Albert-László Barabási[23] says that "the nodes always compete for connections because the links represent survival in an interconnected world."

> This competition is mostly dulled within a personal learning network, but the assignment of value to certain nodes over others is a reality. The nodes that are assigned greater value will be more successful in acquiring additional connections. In a learning sense, the probability that a learning concept will be connected depends on how stable its current connection is. Nodes (which can be fields, ideas, communities) that specialize and gain recognition for their knowledge have higher chances of recognition, thus resulting in the cross pollination of learning communities[24].

Therefore, "it may be noted that the nodes do not refer to human actors only, but can also be databases, libraries, organizations, i.e., any information source, which makes the possibilities of establishing connections endless"[25].

1. INTELLECTUAL CURIOSITY

In the article "How the death of the humanities will kill science – Discovery comes from curiosity", by James Bank[26], the most interesting part is the final paragraph: "Education initiatives are usually about one silver bullet policy or another, whether it is a national curriculum or vouchers or putting younger enthusiastic teachers in classrooms. But fostering intellectual curiosity is not something that can be easily put into a policy or a curriculum. It depends on more than this; it depends on the culture of the school and the values of the students and instructors"[27].

Not all institutions allow the use of active methodologies.

20. Ibidem.

21. Ibidem.

22. Ibidem.

23. BARABÁSI, 2002 apud SIEMENS, op. cit., 2005.

24. Ibidem.

25. Ibidem.

26. BANK, James. **A morte das ciências humanas vai matar também as exatas**. Available in: <http://pt.aleteia.org/2016/01/26/a-morte-das-ciencias-humanas-vai-matar-tambem-as-exatas-2/?ru=b4127ec0c12e59207195a9bc32e85f72>. Access on: Sep. 18, 2016.

At least in their simplest forms, teachers know about means of teaching and learning that can be considered a type of active methodology, even if they are not labeled as such. Teaching through projects, as well as teaching through problem solving, are typical examples of active learning methodologies[28].

Regardless, educators should not start to develop an educational policy without, at least, recognizing that "the next technological revolution will not come from people who always have the right answer; it will come from people whom learning has endowed with enough intellectual curiosity to feel comfortable when they get the wrong one"[29]. Bank claims and is categorical when reasoning that

Educators and technocrats incorrectly believe that we know or have thought of everything that we need for the next economic boom or scientific revolution. It is just a matter of giving the next generation the answers that we already have. But it is less important to train people how to get to the next frontier as it is to educate them so that they will be able to discern what frontiers are worth going to[30].

In short, the idea is to encourage debate and disagreement, improve the students' critical thinking skills and their creativity. Unlike mathematics, says Bank, in the liberal arts, "there is rarely an answer to the question that is clearly correct. [...] there is never any one perspective that will serve indefinitely. This is not because the "best which has been thought and said" has changed over time; rather, the world has".

The power of ideology and bureaucracy is based on alienation (like a frenzy), which extracts thoughts and actions from every individual, says Perniola[31], "but this alienation proved insufficient; our times demand and require something more: the alienation of feeling, its transference to the exterior, its positioning as something independent, social and collective"[32].

Let us not be radical. Despite being aware of the existence of people who are entrepreneurs, often successful (as they had to be, to reach the position they currently occupy), Bank, when referring to the participants of a congress, reports what was said by them: "But they [the people] essentially wanted to train the next generation to fill the exact roles and have the exact knowledge that they had themselves"[33].

The author reminds us that this is not exactly the way the world works and that the problems of tomorrow "are always different than the problems of today and the solutions that work today are not going to answer all of the issues that will arise over the next decade. Adapting to tomorrow can only be done from living in society itself"[34]. As already claimed by Siemens in 2004[35]: "Our ability to learn what we need for tomorrow is more important than what we know today, and that is why the real challenge of any theory of learning is to activate knowledge at the point of application".

In current times, living in society implies being in a context of convergence, or even post-convergence, of the media and of "navigation through the liquid architectures of information", as emphasized by Santaella[36]: "every educational

27. BANK, op. cit.

28. BARBOSA, Eduardo Fernandes; MOURA, Dácio Guimarães de. Metodologias ativas de aprendizagem na educação profissional e tecnológica. **Boletim Técnico do Senac**, Rio de Janeiro, v. 39, n. 2, p .48-67, 2013.

29. BANK, op. cit.

30. Ibidem.

31. PERNIOLA, op. cit.

32. Ibidem.

33. BANK, op. cit.

34. Ibidem.

35. SIEMENS, 2004.

36. SANTAELLA, Lucia. **Curso de especialização em educação na cultura digital**. Linguagens do Nosso Tempo. 1. ed. Brasília, DF. MEC, 2014. Available in: <http://catalogo.educa caonaculturadigital.mec. gov.br/hypermedia_files/ live/linguagens_do_nosso_ tempo/apresentacao.html>. Access on: Dec. 12, 2016.

process is cultural and socially overdetermined. This means there is no way to separate education from the cultural conditions under which it is developed."

The navigation in landscapes of information and knowledge, the creation of virtual working groups at local, regional, national and global scale, the numerous forms of possible interactions between Internet users and their virtual worlds create a huge amount of innovative behaviors that generate profound social, cultural and educational consequences[37].

A reality in constant transformation frightens those who believe to be stabilized and who avoid facing the evolution of technology and of the life within it. According to the results of Mattar's research[38], "although some authors argue that Connectivism should not be considered a new theory of learning"[39], Downes, another theorist of Connectivism, proposes:

a network-based pedagogy and Siemens (2005) discusses the limitations of Behaviorism, Cognitivism and Constructivism as learning theories, because they would not address the learning process that occurs outside of people (i.e., that is stored and manipulated by technology) nor the one that occurs within organizations[40].

Siemens[41] lists some of the central points in his theory, among them: "Understanding, consistency, sensemaking, meaning: these elements are prominent in Constructivism, less in Cognitivism, and are absent in Behaviorism", and points out that in Cognitivism, "the rapid flow and abundance of information raise these elements to a critical level of importance". According to the author, the content "we learn has to be up-to-date, relevant and contextually appropriate. The topicality of knowledge[42] is a function of the network, which in turn becomes a separate cognitive element: it processes, filters, evaluates and validates new information"[43].

After analyzing the perspectives postulated by behaviorists, cognitivists and constructivists on knowledge/learning, Siemens discusses aspects relating to Connectivism and presents their differences and similarities.

Table 1: Learning theories systematized by George Siemens[44]

Properties	Behaviorism	Cognitivism	Constructivism	Connectivism
How does learning occur?	Black box – focus on observable behavior	Structured, computational	Social, meaning constructed by each apprentice (personal)	Distributed in a network, social, technologically optimized, recognizing and interpreting patterns
Factors of influence	Nature of reward, punishment, stimuli	Existing schemes, previous experiences	Engagement, participation, social, cultural	Diversity of the network

37. SANTAELLA, op. cit.

38. MATTAR, João. Aprendizagem em ambientes virtuais. **Revista Teccogs**, n. 7, jan.-jun., 2013. Available in: <http://www.pucsp.br/pos/tidd/teccogs/artigos/2013/edicao_7/2-aprendizagem_em_ambientes_virtuais-joao_mattar.pdf>. Access on: Oct. 17, 2016

39. Authors analyzed by Mattar are: Verhagen (2006); Kerr (2007); Kop; Hill (2008); Bell (2011).

40. DOWNES, 2011 apud MATTAR, op. cit.

41. SIEMENS, George. **Knowing knowledge**, 2006. Available in: <http://www.elearnspace.org/KnowingKnowledge_LowRes.pdf>. Access on: Mar. 12, 2015.

42. Siemens recognizes the contributions of learning theories in the formulation of connectivism: "all ideas are heirs of others and all concepts have roots". Thus, among the main roots of connectivism are: the notion of community of practice of Lave Wenger - and to some extent of Papert, who considers learning as a phenomenon situated, resulting from participation in communities of practice; the social learning (constructivism) of Vygotsky and Bruner; more recently elaborated, Stephen Downes' work on connective knowledge and the concept of rhizomatic and community knowledge as a curriculum by Dave Cormier, among many other references (SIEMENS, 2008).

43. SIEMENS, 2006, p. 43.

44. Ibidem, p. 36.

Properties	Behaviorism	Cognitivism	Constructivism	Connectivism
What is the role of memory?	Memory is the inculcation of repeated experiments — where reward and punishment are most influential	Encoding, storage, recovery	Prior knowledge remixed for the current context	Adaptive patterns, representative of the current state, within the networks
How does transfer occur?	Stimulus, response	Duplication of the constructs of knowledge of those who know	Socialization	Connection (addition) with nodes
Better explained types of learning	Task-based learning	Reasoning, clear objectives, problem solving	Social learning emphasizing interaction through observation	Complex learning, a constantly changing core, various sources of knowledge. It is the integration of principles explored by chaos, networks and theories of complexity and self-organization. Learning is a process that occurs within nebulous environments where the central elements are constantly changing – not entirely under the control of the individual.

Connectivism – or distributed learning, according to the contribution by Downes[45] –, in the synthesis of Mattar, "is thus proposed as a theory that is more suited to the digital age, when action without personal learning is required, using information beyond our primary knowledge"[46].

Both the issue of successive changes and the issue of learning also with what is outside of us are highlighted by Siemens and by the authors who cite him. Before that, it should be emphasized that connectivism is the integration of principles explored by chaos, networks, complexity and self-organization. However, learning, according to Siemens[47], "is a process that occurs within nebulous environments where the central elements are constantly changing – not entirely under the control of the individual". Learning (defined as applied knowledge), for Siemens, "may reside outside ourselves (within an organization or database) [...] it is focused on connecting sets of specialized information, and the connections that allow us to learn more are more important than our current state of knowledge"[48].

Mattar stresses the issue of the potential external connections of Connectivism:

Learning theories should be adjusted in a time when knowledge is no longer acquired in a linear fashion, technology involves many cognitive operations that are previously performed by apprentices (storage and retrieval of information) and, in many instances, this performance is necessary in the absence of a thorough

45. One of the first very important contributions of Downes was, precisely, adding to the two traditional types of knowledge considered – qualitative and quantitative – a third one: the distributed, which may be described as "connective", thus stated by the author: *"A property of one entity must lead to or become a property of another entity in order for them to be considered connected; the knowledge that results from such connections is connective knowledge"* (DOWNES, Stephen. An introduction to connective knowledge. 2005. Available at <https://www.downes.ca/cgi-bin/page.cgi?post=33034>. Accessed on: Nov. 6th, 2018.

46. MATTAR, op. cit.

47. SIEMENS, 2004, p. 5-6.

48. Ibidem.

understanding. Moreover, cognition and learning are distributed not only between individuals but also between artifacts, since we can relegate cognitive work to devices that are more efficient than human beings themselves in the performance of tasks[49].

2. ACTOR-NETWORK THEORY (ANT) AND CONFLICT RESOLUTION

In terms of reasoning, we can refer to the work of Bruno Latour on the principle for the ANT's consequences, substantiating that "the networks constitute social life, not as its structure, but as the relation that gives way to it. Everything can and should be seen as 'actor-network'", as summarized by Lemos[50]. Behind an apparent individualization is "the movement in network of actants and mediators participating in conflict resolution. Therefore, every object (human and non-human) is a temporary stabilization of its trajectory (substance and non-substance), of the individuality and dynamic network that constitute it, says Latour"[51].

> The actors' activities consist in making connections and alliances with new elements of a network and thus become able to redefine and transform the components of this network (Callon, 1986, p. 93). [...] The actants-actors in the ANT correspond to any species of figures endowed with the ability to act, including people and material objects: inscriptions (any written text), technical artifacts, entities under study, concepts, organizations, professions, money etc.[52]

Derived from Greimasian semiotics, actant designates any active element, whether human or non-human, responsible for some type of transformation in the course of action of other elements[53]. Humans and non-humans represent the refusal to assume formulations based on the subject-object opposition and all its negative consequences for the sciences[54]. The Actor-network theory "has been appropriated in different ways by the Humanities and Social Sciences, especially by researches in which technology and science occupy central roles"[55].

On the other hand, Bank makes it clear how the Humanities have the ability to interfere in the learning process in a significant way. They "can do more than help us understand what we should not be doing: they can help us contemplate what we should do"[56] instigating curiosity when reminding us that we may be "far away from the classical world that separated the liberal arts (*artes liberales*) from the technical arts (*artes serviles*), but the liberal arts are still essential because they promote intellectual curiosity and the desire to learn for the pleasure of learning" [57].

Santaella[58] is right when reminding us that "all these innovations started to increasingly become part of our homes, places of work, of education, and with this, an environment of semantic and cognitive technologies that, far from behaving like tools, became part of the environment, started being formed". Thus, she adds that "we are inhabiting ecologies that are saturated with such

49. Ibidem.

50. LEMOS, André Luiz Martins; RODRIGUES, Leonardo Pastor Bernardes. Internet das coisas, automatismo e fotografia. **Revista Famecos**. Porto Alegre, v. 21, n. 3, p. 1016-1040, Sep.-Dec. 2014. Available in: <http://revistaseletronicas.pucrs.br/ojs/index.php/revistafamecos/article/download/.../12574>. Access on: Apr. 16, 2017.

51. Ibidem.

52. LATOUR, Bruno. **Reagregando o social:** uma introdução à teoria ator-rede. Salvador: EdUfba, 2012, p. 38.

53. HOLANDA, 2014.

54. Ibidem.

55. LATOUR, Bruno et al. O todo é sempre menor que as partes: um teste digital acerca das mônadas de Gabriel Tarde. Translated by Flávia Gonsales and Beatriz Redko. **Parágrafo**, v. 2, n. 3, Jul./Dec. 2015. Available at: <http://revistaseletronicas.fiamfaam.br/index.php/recicofi/article/view/329/336>. Accessed on: May 22, 2016.

56. BANK, op. cit.

57. Ibidem.

58. SANTAELLA, op. cit.

technologies, some of them adaptive, to the extent their designs are able to provide us what we need to deal with what we are and what we do"[59], and concludes: "with this, various kinds of challenge are emerging; among them, the educational challenges are the ones that must be addressed most urgently"[60].

Siemens is one of the theorists who analyze and triangulate learning chains with interdisciplinary by referring to other sciences or disciplines that may indicate that "the exponential growth of knowledge, the emerging research (in Neuroscience and artificial intelligence)", in addition to the "new philosophies of knowing and the growing complexity which distributed knowledge and interpretation require, no longer find sufficient answers in the existing major theories of learning"[61].

The experience of learning can be defined as the moment when we acquire, actively, the knowledge that we needed to complete a necessary task or solve a problem. Learning is multifaceted, driven and determined by tasks.

It is about, in essence, bringing to the learning experience elements that allow going beyond the classroom, the course, integrating it in real life, so that people, especially in areas where information quickly expands, may stay up-to-date. It is not in traditional courses and institutions that this adaptability, self-sufficiency and permanence of knowledge (while it is needed by the apprentice) may be found, but in a notion of learning as ecology, community, network[62].

Learning spaces and structures themselves are what move and transform, says Siemens; inspired by figures such as Ivan Illich or Paulo Freire, she states:

> a pedagogy of participation leading to a loosening of the institutional hierarchy and an opening and spreading of the classroom in new ecologies of learning (its spaces) where communities and networks (its structures) can flourish and diversity, dialogue and active participation may occur, is aspired to[63].

Santaella emphasizes: "developing integrative strategies to join the game of complementarities presented to us by the current media constitutes the major challenge of educational systems in the contemporary world"[64]. But the greatest challenge that ubiquitous (free, open) learning, evidenced by the author,

> represents to educational systems, is the pressure that it exerts on the traditional role of the teacher, who now, more than ever, is far from being the keeper of knowledge. When learning is in the open, any apprentice can offer his master information he does not have. Conclusion: new forms of dialogue are emerging, for which the teacher must be prepared, with sheer confidence regarding the fact that the era in which he used to be the absolute keeper of the transmission and transfer of knowledge has been left behind[65].

After all, as stated by Santaella: "open learning processes mean spontaneous, unsystematic and even chaotic processes, up-to-date in relation to existing circumstances and curiosities"[66].

We conclude this brief reflection on active learning with the valuable help of Siemens, of the authors who study him and other authors; and finally resume the approach to chaos, first mentioned in the beginning of this article. For

59. Ibidem.

60. Ibidem.

61. MOTA, José Carlos. **Da Web 2.0 ao e-Learning 2.0**: Aprender na rede. Dissertação de mestrado em Ciências da Educação, especialidade Pedagogia do e-Learning, Universidade Aberta, Portugal, 2009. Available in: <http://orfeu.org/web learning20/>. Access on: May 21, 2015.

62. SIEMENS, George. Learning ecology, communities, and networks: extending the classroom. In: HUG, Theo (ed.). **Didactics of microlearning**: concepts, discourses and examples. New York: Wasmann Verlag, 2003.

63. Ibidem.

64. SANTAELLA, Lucia. **Comunicação ubíqua: repercussões na cultura e na educação**. São Paulo: Paulus, 2013, p. 6.

65. SANTAELLA, op. cit

66. Ibidem.

Siemens, chaos is a new reality for anyone working with knowledge. *ScienceWeek* cites the definition by Nigel Calder that chaos is "a critical form of order. Chaos is the rupture of predictability, evidenced in complicated arrangements that initially defy order"[67] and shows that, unlike constructivism, for which students try to promote understanding through tasks of creation of meaning, "chaos affirms its existence – the student's challenge is to recognize the patterns that seem to be hiding. Assigning meaning and forming connections between specialized communities are important activities"[68].

We therefore propose applying the actions, transcriptions, interactions with our actors-network-students in daily life, to our benefit as well, so that we, who never stop studying, may acquire alongside them new lessons in journalism that will serve us for the rest of our lives.

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67. SIEMENS, op. cit., 2005.
68. Ibidem.

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