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Neuro-Epistemological Aspects of Digital Hypertext as a Mediator Learning

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Abstract: *this article approaches the concept of digital hypertext as a mediator of learning. Show some aspects of neuro epistemology, especially regarding the importance of perceptual categorization, attention and hedonistic centers of the brain for memory and learning. They name the studies of edelman on the selectionist brain theory and the squire and kandel on the memory. Presents the obstacles that in perspective neuro epistemology difficult reading and understanding of hypertext that can cause cognitive overflow reader's disorientation and retroactive interference in attention and memory. Add up observations on the reading and the characteristics of digital natives. Anyway, it is clear on the need to know the players and take into account your world or your eco-socio-family niche.*

Keywords*: Hypertext Digital, Learning, Mediation, Memory, Neuro epistemology.*

I. Introduction

The term "hypertext" in a quick search on Google®, has about 1,370,000 results. In this way, the purpose of this article is to bring some reflections on some neuro epistemological aspects in relation to hypertext as digital mediator.This article briefly introduces the concept of hypertext linking it to learning. Then, some neuro epistemological considerations are presented, with emphasis on studies of Edelman (1987 and 1992) on how to create knowledge, and Squire &Kandel (2003), about memory. From these considerations, it is made an application to the digital hypertext, follow by the section that deals with the obstacles that this may have. In this section, we indicate, then, how these barriers can hinder the understanding of hypertext, due to excessive cognitive load, the reader's disorientation and retroactive interference of hypertext inserts.
Finally, we present considerations on hypertext reading and on the digital natives.

II. Digital Hypertext and Learning

Learning is transforming or acquires new behaviors through the activity of the learner and this transformation or adaptation does not occur by maturation, as pointed out by several authors.
In this perspective, Mayer (1982, p. 1040), defines learning as "a relatively permanent change in knowledge or behavior of a person because of the experience."
Similarly, Schuell (1986, p. 412) defines learning as "a lasting change in behavior or ability to behave in a certain way, which results from practice or other forms of experience."
Therefore, learning is to change behavior or adapt to new situations, then the learning process requires mediation. Learning is always mediated.
The concept of mediation in learning was coined by Vygotsky. According to him (. 1993, page XX), "Mediation is ... the intervention process of an intermediate element in a relationship; the relationship has ceased to be direct and starts to be mediated by this element ". He adds that "mediation is an essential process to make possible psychological activities."
For Vygotsky (op. Cit.), Learning proceeds, as for almost all human actions, through mediation, this is a fundamental concept in his theory. In fact, the human being does not have direct access to real-world objects, but access mediated by a mental representation of the world in which it is inserted by your mental model. In this sense, one of our most persistent illusions - and perhaps more limiting - is the belief that the world we perceive is the real world.
According to Siemens (. 2006, page 8), there are four areas of knowledge acquisition(Knowing):

- Physical (Sensorimotor);
- Cognitive, emotional (affective)
- and spiritual.

In fact, the human being is, above all, a spiritual being, an intelligent being that adapts to new situations and acquires behavior is by imitation, or by conditioning, or even for education that requires the acquisition of new knowledge. So learning is also acquiring knowledge.Therefore, learning can be defined as a cognitive process by which the human may transform information into knowledge. If learning is always a mediated activity, then the digital hypertext is a learning tool since, according to Laufer (1993) includes three types of proposed by Lewis learning (1986): not active learning, the use mouse in physical actions such as pointing or dragging; iconic representation, including the use of icons and other graphical representations on the screen, as well as the ability to access videos; symbolic representations, including the use of text on the screen as well as hypermedia programs produced by hypertext. This is a didactic presentation of texts that serve to mediate learning. Defining cyberspace created by digital media, Lévy (2008, p. 92) evokes the character of information's hyper textuality that digital sources convey that make digital texts plastic, fluid generating a space where anyone can have free access, an open space to the exploitation of individuals. Hypertext is therefore a form of writing that enables the reader and student choose their path and track, from associations and insertions or remissions to which the text sends a non-linear way. Insertions, links and references to other texts which are accessed immediately are semantic and correlated to the topic character. As appropriately stated Xavier (2004):

"Hybrid form, dynamic and flexible language that converses with other semiotic forms, which adds wastebasket and other forms on its surface, other forms of textuality. Enables reading with co-production of text and hypertext (Reading, text and hypertext) "(AC XAVII-IR - 2004 - tpleitura.pbworks.com, p .170).

There is a dialog in hypertext itself, between its constituent elements referring to each other in order to facilitate understanding of, not only the above explanation, but the coproduction by the reader itself. In other words, hypertext way requires an active and constructive reader, motivating him to exercise his own imagination. This kind of language and multimodal communication expands the semantic field, bringinginformation, links, videos and other sources of information, which provide resources for co-construction of meaning, for the co-creation of knowledge. As Siemens (.. Op cit), the knowledge flow cycle begins with some kind of knowledge creation (individual, group or organizational) and then moves through the following steps: **Co-creation** (it is a recent addition to the knowledge flow cycle): the ability to build on / with the work of others opens the door to innovation and rapid development of ideas and concepts); **Dissemination** (elements of analysis, assessment and filtering through the network) is the next stage in the knowledge flow cycle; **Communication** (those who survived the process of dissemination of key ideas); **Personalization**: In this phase, we bring new knowledge to ourselves through experience, interiorization, dialogue or reflection. **Implementation**: is the final stage, where the action occurs and gives feedback to the customization phase. Our understanding of a concept changes when we are acting upon it, in contrast when we only theorize or learn about it. Actually, the hypertext language should be interactive, very characteristic of a digital language, exceeding the linearity of printed writing. Silvana Monteiro Drummond (2000) concludes that:

"Therefore, along with the concept of non-linearity in hypertext comes the principle of interactivity, not a true premise for the printed text, although it has connections, however connection is not necessarily synonymous with interactivity" (http: //www.pucsp. Cimid / 8inf / monteiro / linghipe.pdf).

III. Neuro Epistemological Considerations

According to some authors (DANTAS, J. G., 2008) hypertext simulates the human mind in the organization of memory as a semantic network in which the concepts are connected by association. One can then ask: do brain associations come to chance as some texts seem to suggest that they invoke non-linearity?

Edelman (2007), explains the formation of knowledge by the brain, by neuronal Darwinism, by the selection of neural groups (TGN). According to him, evolution occurs by selection, which was previously explained by the theory of instruction, in which there would be transfer of information between the environment and organisms. In other way, the theory of selection explains the evolution by recognition, similar to what occurs in the creation of antibodies by the immune system, as explained in the book Biologie de la Conscience:

By "recognition," I understand the adaptive and continuous correspondence of the elements of a physical domain given to novelties or changes occurring in the elements of another physical domain more or less independent of the former, adjustment that is made in the absence of any prior instruction. (EDELMAN, 1994, pp. 113 and 115).

Following this theory, if evolution occurs for a long period of time, it generates selective systems within individuals, forming adaptive selective somatic systems. This leads Edelman to propose the hypothesis that the brain behaves as a selective, somatic system as soon as neurobiology is also part of the recognition sciences (Op cit, pp. 116 and 117). But for this recovery and if the brains operate by selective recognition (EDELMAN, 1994 and 2007, passim), it does not mean that selection is by chance. It is necessary that the brain has a repertoire of neurons that makes it apt to make the necessary recognitions or selection. The memory that perpetuates or allows long-term potentiation (LTP) modifications and amplification of selective events is required. Brain modifications would be knowledge. According to Leo Szilard:

"Thought would induce the making of new proteins by our brain. After some time, these new proteins would stimulate others, similar to the antibodies, that would represent the memories "(EDELMAN, 1994, p 123).

According to Edelman (Op. Cit.), the evolutionary assumption necessarily requires that the brain and body be embedded in the environment (eco-niche). Thus, our path of evolution depends on the conditions of the situation, the family, sociological and cultural niche.

"Evolution takes place in a particular historical sequence of natural selections that take place within a population of diversified organisms. This is not taken into account by physics "(Edelman 1994: 32).

Since human cognition is always situated (BROWN, J. S. et al., 1989), learning always occurs in a memory evocation fund, it is a necessary condition for learning, although it is not sufficient. There is no learning without memory, therefore, *Memory collects the countless phenomena of our existence into a unitary whole... Were it not for the unifying force of memory, our consciousness would shatter in as many fragments as the seconds already lived. (HERING, Ewald, In: SQUIRE & KANDEL, 2003, p.14)*

The memory allows the evocation of facts, experiences and information collected by the individual not only when the individual studies, but of everything learned in the evolution in an eco-cultural niche. Both procedural (mechanical or unconscious) memory, and declarative (conscious) memory involve synaptic reactions. Kandel presents synthetically what occurs in learning and memory: *With remarkable insight, Ramón y Cajal (?) Formulated the hypothesis, now called the synaptic plasticity hypothesis, which says that the intensity of synaptic connections - the ease with which an action potential in a cell excites (or inhibits) its target cell - is not stay, but plastic and modifiable. (...) Learning would produce prolonged changes in synaptic connections, through the growth of new synaptic processes, and the persistence of these anatomical changes could serve as the mechanism for memory. (SQUIRE and KANDEL, 2003, p. 47).*

The studies of the memory of Eric Kandel and his collaborators are based on the studies of the habituation of the Aplysia, that awarded him the Nobel prize. As in Aplysia, words and hypertext links cannot be recognized if there are no neurophysiological reactions (proteins, dendrites, etc.) in the brain, making comprehensible reading possible.Understanding the reading of hypertext requires the fundamental triad of higher brain functions, formed by perceptual categorization (perception), memory (memorization), and learning (cognition). The perceptual categorization of information, starting with the data that is captured from the environment by the senses, is operated by the synaptic connections that connect and reconnect, according to the principles previously mentioned. Perceptions do not produce images of objects and the world (Edelman, 2007, p. 47. As Eccles and Popper pointed out):Each one of us believes to be living directly in the surrounding world, feeling its objects and events in a precise way, living in a real time, that normally happens. I assert that this is only an illusion of perception (,,,). These sensory nerve fibers are not high fidelity recorders, as they accentuate certain aspects of the stimuli, neglecting others. The central neuron is a storyteller, (,,,). Feeling is an abstraction, not a replica of the real world (ECCLES and POPPER, 1991, p. 315).

Memory, attention, and perceptual categorization require the collaboration of the value or hedonistic system of the brain, as will be seen later.

Of course, one of the fundamental conditions of learning is attention, which requires concentration. Due to the attention, information can be provisionally stored in the short term or short term memory (STM), which can cause long term memory (LTM), where knowledge can be represented on a permanent basis.

The short term memory has two aspects: immediate and working memory. Immediate memory is instant memory that lasts a few seconds. When the immediate memory extends for minutes and even longer and allows recapitulation is called working memory. Synaptic connections enable the individual to hold the information long enough to relate current perception or text that reads to the subject or object they are studying or observing.*However, even after recapitulation, it can remain in temporary form. This extended temporary phase of memory can last up to an hour or more, constitutes what we call short-term memory. The short-term memory has three characteristics that help to clarify the basic mechanisms of storage: 1. It is transient; 2. Does not require anatomical changes to be maintained and 3. Does not require new protein synthesis (SQUIRE & KANDEL 2003, p.145).* Short-term memory will be transformed into long-term memory by the formation of a greater number of neuronal innervations by the dendrites. A single experiment, with a single shock or a single quick reading does not cause the production of new proteins. For there to be long-term memory that will be the Knowledge base, it is necessary that the reading can cause changes in the neural connections (by proteins) and the formation of new dendrites. These will produce new dendrites that will innervate the axons. The more dendrites are formed the longer the memory of the student will last, allowing evocation months and years later.

The assumptions presented here explain why the "recovery tip" of memory is efficient. The tip can be compared to Pavlov's conditioning or operative stimulus: the ringing of the bell by itself would not provoke the salivation of the dog if there was no association explained by HEBB (1949). Therefore, in hypertext the introduction of a link or information must constitute tips, and be something as exciting as to sensitize the reader to the information retrieval, provided by it. According to SCHACTER (1999, pp. 182-203), when discussing the importance of tips, he says that Research Cues should be able to revive memory, and the most efficient

evocation tips are Those that awaken better codified aspects of the event that one is trying to remember (Idem, 85).According to SQUIRE & KANDEL (2003):

The evocation is much more successful when the context and tips were present when the material was first learned are the same as the context and ideas present later when one is evoking that memory (Idem, 86).

IV. Applying to Hypertext Reading

In relation to the attention one has to take into account the role played by the value systems that are and the neurotransmitters. *Although categorization and memory are necessary for learning, they are not enough. They must also be connected to value systems through parts of the brain that are different from those that categorize. The sufficient condition for adaptation is provided by the connection of the so-called hedonistic centers and the limbic system of the brain, so as to satisfy homeostatic and other needs. The various brain structures loaded with values - above all the hypothalamus, various nuclei of the midbrain and others that appeared during evolution. (Edelman 1994, p.155).*

Connections and interactions between neurons and synapses are regulated through systems which are the various neurotransmitters. Dopamine is found in the ganglia of the base and brainstem, whose release acts as a reward system favoring learning.

The value systems consist of ascending neural networks scattering the synaptic responses by abundantly releasing neuromodulators or neurotransmitters. Example: dopamine. (Idem,76).

According to TAPSCOTT (2010), the young digital or young Net are unable to pay attention, at least for the texts and activities that are usually requested of them. Those who play videogames have broader and sharper perceptions, and process visual information more quickly (TAPSCOTT, 2010, p.125).

However, Gary Small (2008) and other experts point out that the use of the computer and other digital means modify the frontal regions marked by it. Betsy Sparrow et al. (2011) have experimented and found that constant Internet access makes digital natives and even those who constantly use these means create an external storage memory. They do not memorize anything, or memorize very little. They trust the ability to locate information with a few clicks. It could be said that, in the end, the sharp and indiscriminate use of the Internet is making people increasingly superficial. They are more selective in choosing texts and faster. In a world in which everything flows and becomes ever more changeable, these qualities are not despicable.

This lack of concentration occurs when activities do not stimulate brain value systems that are responsible for the interest and the continued effort to maintain concentration and effort so that the individual does not disperse. For understanding what is read, it is necessary that the structural and procedural aspects of cognition be organized and engaging. Reading is a mediator of knowledge and learning if working memory is efficient. For this, the hypertext material must be well organized, because mismatched information, unrelated and not appropriate to the theme, produces user disorientation and cognitive overflow.Formal experiments show that memory is especially accurate for meaningful visual material (STANDING, Lionel in SQUIRE & KANDEL, page 93). Categorizing for memory is important. Human cognition is essentially organized as a semantic network in which concepts are linked by associations. The hypertext system attempts to explore this basic nature of cognition. Human cognitive aspects have characteristics that make hypertext a computational tool that supports thinking and communication. Human memory is structured in such a way that we understand and retain much better everything that is organized according to spatial relations; the domain of any area of knowledge almost always implies the possession of a rich schematic representation (LEVY, 1993, p.40). According to Fiderio (1988: 238) "... the hypertext imitates the brain's ability to store and retrieve information through referential links for quick and intuitive access." Carlson (1991, p. 134) states that "the virtual aspects of hypertext mimic the human brain particularly in the associative quality of memory."

V. Neuro Epistemological Obstacles in Reading Hypertexts

According to Gaston Bachelard (1996), in the production of knowledge there are always factors that provoke stagnation and even regression that are denominated by him of epistemological obstacles.

As neuro epistemological obstacles, they point to user disorientation and cognitive overflow (LIMA, G.A.B., 2004) and the effect of retroactive interference (SQUIRE & KANDEL, 2003, p.146).

5.1. The cognitive overflow

Cognitive overflow occurs when the information contained in the hypertext cannot be computed by the brain, because the memory capacity is limited (SQUIRE & KANDEL, op. Cit.). The creation of new terms that the reader does not master or the introduction of links with which the reader is unfamiliar without previous semantic knowledge creates confusion and opens space for misunderstanding. Links distract attention, as research by Nicholas Carr (2011, pp. 175-177) proves. This author states that hypertexts, by definition, contain links and hyperlinks, which then allow the reader to enter the world of the web. In this case, the reader is in a situation where he sees the forest, but does not distinguish the trees. In fact, in the 1980s, no criticism was made

of hypertexts, only its possibility was shown to instrumental the reader for greater and better clarification on a theme. Summing up the discussions and contrasting with Landow (1992) and Delany (1992) the hypertext, according to Carr (op.cit.) has an excessive cognitive load. Such a burden overwhelms the brain by not allowing it to delve deeper into the limitations of the brain itself, according to the neuro-cognitive sciences. In addition to surfing between links and hyperlinks, zapping between different subjects, add the reveries proper to the normal distractions of a youth prone to maximum dispersion against minimal or no concentration (MATOS, O. C. F., 2006, pp. 26-35).

5.2. The disorientation of the reader

In order for the working memory to be efficient, the hypertext material must be well organized and well located. This is necessary because mismatched and unrelated information and not appropriate to the subject produces user disorientation. In this way dispersion does not occur, which can also be overcome if the structural and procedural aspects of hypertext are well organized and presented in a captivating way. Formal experiments show that memory is especially accurate for visually significant material (STANDING, L. in SQUIRE & KANDEL, p.93). Although the authors Bárbara MônicaAlcântaraGratão Rodrigues and Moema Gomes Moraes affirm that for the *Homo Zappiens the present system should erase from its records the structures of linearity in thought; Systematized activities, making them authors and protagonists of learning. The new interface of this system must be multitasking, based on hypertext links that lead the reader to navigate the unknown through paths chosen by them, reinforcing the apparent randomness of this navigation and building the pillars of an interactive scenario, where the student collaborates directly with Their learning process, guided by parents or teachers (2010, p.17).*

This assertion is valid in part as regards making the student the protagonist of his learning and that the system can no longer be the same as the traditional one, but denying linearity does not mean that one should not take into account the observations about how the brain learns. Zapping can lead and leads to lack of concentration, without which there will be no attention, no learning.

5.3. Effects of retroactive interference

SQUIRE & KANDEL (op cit), report the experiences of Müller and Pilzecker (2016):

They found that even after the event has been entered into memory, some time must elapse before the memory trace reaches a stable, long-lasting form. During this period, which they called the consolidation period, memory is liable to harm them. The key finding was that learning a second list of meaningless syllables, immediately after learning the first, interferes with the later recall of the first. They called this effect retroactive interference (Idem, ibidem). If the retroactive interference effect holds for long-term memory, much more applies to short-term memory, especially to working memory. In the reading of texts in hypertextual form the reader is faced with links and insertions that interfere in the attention, soon in the working memory. The reader can either read hypertext in a linear fashion without following the links' directions and then dwell on them. The reading of the links will reinforce the read according if the content is continuity of the writing. On the contrary, it will exert retroactive interference if it is not memory enhancement. In any case, this bouncing can exceed the capacity of attention and retention, capacity that varies from person to person.

We should point out the observations of Nicholas Carr, who cites research by Jean François Rouet and Jarmo J. Levonen (CARR, 2011, p. 176 - footnote 20), according to which, as readers gain greater "Intimacy with hypertexts" cognitive problems would diminish. However, this did not happen as Research conducted in 2001 by Elisabeth Bowen, along with research by Sean O'Faolein and Erping Zhu and others cited (CARR, 2011, pp. 117-176):

1. Hypertext readers took more time to read the story because the excess of links and nodes causes the reader to fixate on a certain link or node and, thus, their working memory is impaired, since it lasts for only minutes;
2. The absorbed and deep reading mode seems discouraged by the excess of information that causes the dispersion;
3. The attention is directed to the hypertext machinery and its functions, instead of being to the proper theme of the text (1 Idem,177).
4. In view of such assumptions we can add Xavier's statement:

To assert that hypertext is de-linearized is not to say that it is a set of linearly juxtaposed utterances, a mosaic of random phrases. The hypertext presents a greater distance from the traditional forms of hierarchies by being more flexible in its visual formatting, storage of the discursive material and, above all, the units of information. However, in order to be intelligible, hypertext - like any other - must present some linearity, since it cannot subvert the levels of organization of natural languages (syntax, semantics, pragmatics) used by a given society (XAVIER, Antônio Carlos, P.175).

Many characteristics of hypertext result in an increase in the cognitive load and thus may have required a working memory capacity that exceeded the possibilities of the readers.

Hypertext links constitute stimuli of working memory can occur through associations. Association is one of the fundamental laws of memory. In 1949, D. Hebb proposed a principle, according to which synapses are reinforced by associative learning (SQUIRE& KANDEL, 2003: 71). In this way, Hebb provides the biological basis of the laws established by Pavlov, so applied in education and in the explanation of the functioning of memory. But, according to Squire &Kandel (Idem, pp. 85-87), the capacity and specialization of memory do not improve with training.

The only relevant training is a wide practice in the field of the specialty itself ... these years of practice have changed the brain, which can now encode and process the relevant material more completely and in greater detail than the brain of the non-experts. 86). Practice or extensive experience is needed to build working memory and long-term memory. A single reading or a single representation can be compared to what happens with the habituation studied by Kandel with the "Aplysia". In fact, "a single shock in the tail produces short-term memory that can last for a few minutes" (Idem, 81).

VI. Final Considerations

In this article we briefly touched on the concept of hypertext. Some aspects of neuro epistemology were pointed out, especially regarding the importance of perceptual categorization, attention and hedonistic centers of the brain for memory and for learning. The studies of Edelman on the selective theory of the brain and the studies of Squire&Kandel on memory were cited. After applying these assumptions to hypertext, three epistemological obstacles were identified in the reading and comprehension of hypertext that can lead to cognitive overflow, reader disorientation and retroactive interference in attention and memory.The hypertexts constitute a transposition of knowledge by the teachers responsible for the elaboration of didactic material and, consequently, are not identified to an objective or universal knowledge, but it is an interpreted knowledge, as well studied by Chevellard (1991) and the publication organized by SacristánGimeno (2013) and Menezes (2014). One has to consider, in turn, the transposition of the students in what and how they learn and learn what is taught. In this sense, it is crucial to know the students, their stories and how they live their world, their Lebenswelt, and their everyday world outside of school. In the perspective of phenomenology, students, as human beings, are beings-in-the-world-with-others. They depend on the evolutionary history. There is influence of the ecological and cultural niche in which the person is situated that determine its development: *Evolution takes place in a particular historical sequence of natural selections that take place within a population of diversified organisms. This is not taken into account by physics (Edelman 1994, 328). The properties that humans effectively use to determine the relevance of categories are interactive and depend on several biological, cultural, social, and ecological variables (Edelman, 1964).*Although these considerations may at first glance not be relevant to the writing of a hypertext, one wonders: How can the teacher or who writes didactic materials be correct in their construction if little is known about the knowledge that students or readers, Who are studying your text, will understand the relationship of the link (which is a kind of tip), as an explanation or information for a better understanding of the text? It is good to point out that learning occurs on the basis of mental models. How can one be certain of the coherence between the models of the teacher and the models of the students or of the listeners and readers?

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