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NEUROEDUCATION: NEUROSCIENCE TO ADD VALUE TO EDUCATIONAL RESEARCH THROUGH TECHNOLOGY

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ABSTRACT

This article is about neuroeducation, within the context of neuroscience to add value to educational research through technology. In an article published in the Dana Foundation's prestigious virtual space, Hardiman and Denckla (2009) refer to the relevance of what they call the science of education, bringing to light an approach that has been consolidating in recent years, mainly in the United States, through a new multidisciplinary field of knowledge and professional practice in the areas of teaching and educational research, Neuroeducation. The aim of this article is to summarize points that have already been consolidated in relation to Neuroeducation, as well as to reflect on the urgency of disseminating its potential to support educational research based on scientific methodology, involving not only teaching-learning practices and methods from different areas of knowledge, ages and professional profiles, but also to reflect on the possible impacts of contemporary educational technologies on these practices and methods. It was also noted that such educational products need to take into account the integrity of the content; the pedagogical intentions for which they are intended; the cognitive support to fulfill these intentions; and the specific language of the media or technological solution chosen for the function.

Keywords: Neuroeducation. Neuroscience. Educational research. Technology.

INTRODUCTION

In an article published in the prestigious virtual space of the Dana[1] Foundation, Hardiman and Denckla (2009) refer to the relevance of what they called the science of education, bringing to light an approach that has been consolidating in recent years, mainly in the United States, through a new multidisciplinary field of knowledge and professional activity in the areas of teaching and educational research, Neuroeducation. According to these authors, the next generation of educators will necessarily need to take into account the knowledge generated by Neuroscience research when planning and developing their teaching and learning projects.

These topics have been addressed in a structured manner in the general training of designers (especially in interface design and virtual design) and, more recently, through the creation of a new professional area, instructional design (Filatro, 2008). However, they may be included in the training of teachers and all other professionals integrated into multidisciplinary teams producing educational materials, precisely because they imply mastery of knowledge from multiple areas of cognition, integrated with the content in question.

The objective of this article is to summarize already consolidated points regarding Neuroeducation, as well as to reflect on the urgency of disseminating its potential, to support educational research based on scientific methodology, involving not only teaching-learning practices and methods, from different areas of knowledge, ages and professional profiles, but also to reflect on the possible impacts of contemporary educational technologies on these practices and methods.

About neuroeducation: emergence and relevance

Defended in 2008 at Capella University/ USA, Tracey Noel Tokuhama-Espinosa's doctoral thesis (2008), under the supervision of Elena Kays, will be considered in this article as a kind of founding document, since it brings together not only the foundations of Neuroeducation, since its emergence, but also exhaustively describes the set of bibliography already existing on the subject, in addition to the main problems, foundations and principles of the new area of knowledge.

In an attempt to avoid an equally exhaustive repetition of the researcher's work, some of her information is summarized, highlighting, like Tokuhama-Espinosa and authors cited by her, the importance of approaching the subject in a cautious and realistic manner, without intending to establish definitive relationships and conclusions about research results and didactic-pedagogical solutions.

Topics, foundations and principles of neuroeducation

Among the topics cited by Tokuhama-Espinosa (2008), based on his research in the existing bibliography, which delimit possible approaches for research in Neuroeducation, are the various techniques for capturing neuronal information, through electrical signals or brain imaging as an instrument for observing learning4, neurogenesis and plasticity; theories of consciousness and intelligence, neuroethics; differences in learning; and body-mind relationships (sleep and physical exercise, among other items in this Regard).

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She also lists what would be 14 basic principles, to be used as a guiding thread for Neuroeducation, around which premises of the three structuring areas (neuroscience, psychology and education, according to the author) would be articulated, not necessarily in hierarchical order of relevance:

Students learn better when they are highly motivated than when they are unmotivated:

a. Each brain is unique and uniquely organized;

b. Brains are specialized and are not equally good at everything;

c. The brain is a complex, dynamic system that changes daily through experience;

d. Brains are considered ‘plastic’ and continue to develop throughout life;

e. Learning is based in part on the brain’s ability to self-correct and learn from experience, through data analysis and self-reflection;

f. The search for meaning is innate in human nature;

g. The search for meaning occurs through ‘patterning’;

h. Learning is based in part on the brain’s ability to detect patterns and make approximations to learn;

i. Emotions are critical to detecting patterns;

j. Learning is based in part on the brain’s ability to create;

k. Learning is enhanced by challenge and inhibited by threat;

l. The brain processes parts and wholes simultaneously (it is a parallel processor);

m. Brains are designed for fluctuations rather than constant attention;Aprendizado envolve tanto atenção focada quanto percepção periférica;

n. The brain is social and grows through interaction (as well as personal reflection);

o. Learning always involves conscious and unconscious processes;

p. Learning is developmental;

q. Learning recruits the entire physiology (the body impacts the brain and the brain controls the body);

r. Different memory systems (short-term, working, long-term, emotional, spatial, habit) learn in different ways;

s. New information is stored in various areas of the brain and can be recalled through different access routes;

t. The brain remembers best when facts and skills are integrated into natural contexts; and

u. Memory + Attention = Learning6 (Tokuhama-Espinosa, 2008: 79,80.

Among the final findings of Tokuhama-Espinosa's research are some that justify the relevance and urgency of consolidating the new research area, pointing to the need for dialogue between science and its application, in a justified manner and based on observable evidence:

> (...) while thousands of studies have been devoted to explaining various aspects of neuroscience (how animals, including humans, learn), only a few neuroscientific studies have attempted to explain how humans should be taught in order to maximize learning. (...) of the hundreds of dissertations devoted to ‘brain-based teaching’, or ‘neuroscientific methods of learning’, in the last five years, most have documented the application of these techniques, rather than justifying them. (Tokuhama-Espinosa, 2008: 117).

The challenge posed by Hardiman and Denckla (2009) of building bridges for dialogue that can align research methodologies and epistemologies that are diverse and sometimes so antagonistic that they make publications by authors from one area in another unfeasible still remains open.

Produce educational technology with neuroeducational foundations

Moving from the general context of Neuroeducation to the practical needs of contemporary researchers, especially those involved in teaching and learning in scientific and technological areas, such as Engineering, health sciences and other areas of higher education, a universe of questions arises throughout the decision-making processes regarding the best pedagogical practices, as well as the foundations for producing the best educational technology resources.

One can also think of scientific foundations for pragmatic decision-making, in the production of a simple set of slides or an educational video, regarding the use of one or two colors, a font or its size, a background, a texture, a movement, or other items that can alter students' perception or attention. Do such micro-decisions, taken throughout the process of producing educational technologies, have a positive or negative impact on attention, content apprehension, short/long-term memory, consolidation, recall, motivation, reasoning or any of the other items that make up that student's interaction with the content?

Understanding a framework of multiple needs that structure the reality of contemporary educational ecology, it is suggested, then, that the research area of Neuroeducation, if implemented in Brazil, should not be limited to integrating the knowledge of pedagogues, neuroscientists and psychologists, but of all other areas that constitute the so-called Cognitive Sciences6, as well as with the areas of knowledge of Communication and Information Sciences, all of them intertwined in the technological-cognitive-informational-communicational ecology of the Internet, classroom, entertainment and interaction, learning and application, production and reception, among many other characteristics, both opposite and complementary, that characterize education in the 21st Century.

Just as there is no possible return of humans to the world of wireless telegraphy, it is also not plausible to assume that teaching-learning processes will once again depend solely on a good theory or a good blackboard, even if they are integrated with a good neuroscientific foundation. In an attempt to substantiate research on educational technologies applied to scientific and technological teaching, questions have been raised based solely on the determination of a desirable pedagogical model, constructivism, and on the criticism of other models (Schnaid et al., 2003, 2006; Bonini-Rocha et al., 2008b).

It was then realized the relevance of identifying the cognitive and motivational needs of each audience, each area for which the materials and pedagogical projects are intended (Timm, 2005, Timm et al., 2009). It was also realized that such educational products need to account for the integrity of the content; the pedagogical intentions for which they are intended; the cognitive support to fulfill said intentions; and the specific language of the media or technological solution chosen for the function.

Some of these issues were partially synthesized in the form of questions (Timm et al., 2007), some of which are listed below, with the aim of ratifying the relevance of establishing an area such as Neuroeducation, as a promising multidisciplinary territory to qualify contemporary educational research:

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- Does hypermedia-based educational technology, which contains representations (verbal/non-verbal), (...) have an equal impact on students in the humanities, biological sciences and exact sciences? Yes/no/how and why? (...)

- How – and to what extent, and under what specific conditions – can the presence of less or more intelligent ingredients in the computer-based educational ecosystem contribute to overcoming resistance to learning, related to: a) dyslexia or aphasia; b) writing difficulties; c) difficulties in calculating operations?

- (...) - How – and to what extent – does learning new representation languages affect the teacher's ability to communicate with heterogeneous groups of students?

- How – and to what extent – can the teacher's increased (or not) capacity interfere in overcoming students' resistance to learning to think according to the reasoning characteristic of each discipline/profession/area of knowledge?

- Among the variables involved in human cognition, which (and how and to what extent) are most affected by the computing environment (and its different possibilities), in each discipline/profession/area of knowledge?

- What are the ethical limits within which cognitive technology can be considered a cognitive support (educational software, chip-based prosthetics for special needs, etc.) or just a enhancer (intellectual doping) with a view to increasing competitiveness in normal individuals? (Timm et al., 2007).

In addition to these questions, there are others that are beginning to form part of the daily teaching routine, of discussions at events and even of the anxieties of those who need to know whether a video, for example, has the same educational potential as a face-to-face class. Answering these questions – and many others that are beginning to form part of the daily teaching routine – may be part of the delimitation of the territory of Neuroeducation, but it is certainly far from covering it in its entirety.

METHODOLOGY

This paper presents bibliographical information about a new paradigm for educational research, which foresees the integration of research findings from Neuroscience with the need to identify the best ways to teach, in order to enhance learning outcomes. The foundation of this new interdisciplinary area of study is to provide a scientific character to educational research, establishing a theoretical and methodological framework so that the best pedagogical practices can be tested.

Neuro-educational research would encompass a vast field of investigation – of quantitative, qualitative, empirical and even ethnographic natures – including topics such as, for example, learning differences between children, young people, adults, the elderly, as well as between students from different areas of knowledge5, and the impact of different audiovisual technologies on each of them (Ribeiro et al., 2005). Or, even, the differences in teaching-learning involved in the observation that there are different types of theoretical, practical, technical, applicable, memorizable5 knowledge, etc., each of them adapting, perhaps, to one type or another of technological solution (when and why should one choose a video, a game, a dynamic research collection or a simulation, for example?).

Furthermore, it contextualizes ideas and productions with this focus, carried out in recent years by a group of researchers linked to the Federal University of Rio Grande do Sul and other institutions in the region and suggests that this new area can also guide the development and research on the use of educational products, especially those that use computerized technologies, such as multimedia, videos and integrated projects with multiple resources and functions. © Cien. Cogn. 2010; Vol. 15 (1): 199-210.

RESULTS AND DISCUSSIONS

From a philosophical point of view, what has been conventionally called modern thought, in the area of the theory of knowledge, or epistemology, begins with Kant (1724-1804), who recovers Descartes (1596-1650) idea of the epistemic subject (the subject that knows), but frees it from metaphysics, by treating the human mind as an instrument for synthesizing and organizing data obtained through the senses, based on schemes, forms and logical categories that are part of this very mind. A conception so innovative, in its time, that to this day it is considered the "Copernican revolution of philosophy" (Martini, 2006).

The logical evolution of this innovative thought by Kant, which directly relates the understanding of the functioning of the mind with the production of knowledge, could not fail to be due to its intersection with scientific methodology: the observation of the biology of the genesis of knowledge in the brain-mind of humans, in this case, children, as done by the Swiss researcher Jean Piaget (1896-1980).

Possibly, Piaget (1973, 1987) was the great pioneer of this qualitative transformation in the approach to human learning (from speculation to empirical research), when describing, through what he called genetic epistemology, the formation of human thought and knowledge, through mental structures, of increasing nature and complexity, throughout the entire learning process and, therefore, throughout human life.

Observing his own children initially and then expanding to a larger number of children, Piaget was courageous and visionary, in identifying stages of evolution of a learning process that begins with the operation of the world through concrete approach strategies and moves, throughout the maturation of the child and young person, towards abstract logical-formal mental constructions that are more capable of processing the demands of complex knowledge.

Piaget was certainly a genius of synthesis, when he described a basic module through which this permanent learning process occurs in the human mind: assimilation (of new information), accommodation (of new information in relation to the cognitive base previously structured in the individual) and equilibration (a rearrangement of cognitive structures, absorbing the transformations caused by new information in contact with previous information). His observation can certainly be considered a correct model - although quite simplified and certainly incomplete - of what would be a basic process of acquisition, consolidation and recall of memories, in general, seen through the eyes of a neurophysiologist, which could not be different, since Piaget was a biologist, with an eye and reasoning trained by scientific methodology.

Piaget's observation spread throughout the world and supported complex pedagogical interpretations[2], which ended up structuring an important paradigm of thought disseminated today regarding teaching-learning processes, constructivism (Martini, 2006, Bonini-Rocha et al., 2008b). Inspired by Piaget and many of his followers, constructivism preaches, with undeniable reason, the relevance of the learner's action in the process of constructing his own learning.

Based on the understanding of these new demands, intensified by the massive use of new educational technologies, as well as by the evidence of different cognitive, affective, motor and cultural needs of each society and each area of knowledge, the authors intend throughout this text, simultaneously:

- Point out the opportunity to sow academic foundations in Brazil for Neuroeducation, as a territory for multidisciplinary and dynamic research on the challenges that are part of the formal and informal teaching-learning processes;

- Expand the possibilities opened by the multidisciplinarity of this new area of research, towards the set of Cognitive Sciences and the areas of Communication and Information Sciences, to structure a theoretical framework capable of supporting research and the production of efficient and effective educational technologies, which can make the teacher's pedagogical intentions viable, in an organic and ergonomic way to the cognitive processes of each student.

This will be done below, based on a quick bibliographic review about Neuroeducation, commented within the scope of the article's objectives and followed by a reflection on possible contributions of this scientific and multidisciplinary perspective to meet a new and equally intense need: to train good planners, producers and users of educational technologies.

CONCLUSION

Perhaps as a consequence of the literal interpretation and generalization of Piaget's findings to all types of audiences and areas of knowledge; and probably also as a consequence of the lack of dialogue between these generalizations and scientific thought (in this case, with Cognitive Neuroscience, which has evolved significantly in recent decades), it is suggested that constructivism alone does not cover all the needs of contemporary educational research, especially those in higher education in scientific and technological areas, which are currently struggling with the demands of countless variables and the complexity already glimpsed regarding the human information processing system. These limitations may also be related to the fact that most higher education students have already left adolescence, the age range up to which Piaget's research focused with greater emphasis.

It is suggested, however, that the emergence of new educational technologies, their inexorability and their enormous potential to impose updates on new needs and ways of teaching and learning is the opportune moment for educators of all backgrounds to understand the metaphor of the human brain itself, to support the production of knowledge about learning, by processing diverse information, in diverse areas, integrating them through third and fourth areas, in which it will be able to produce meaning and complexity compatible with the knowledge necessary for the student and educator of the 21st century.

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NOTES

1. The Dana Foundation (http://www.dana.org) is a private American philanthropic organization with headquarters in New York and Washington, DC, whose interests focus on brain science, immunology, and arts education. Charles A. Dana, an industrialist, philanthropist, and legislator, served as president of the institution from 1950 to 1966, defining its main programs, which include publications, events, research support, and the dissemination of information about these fields. areas.

2. It is important to remember, in this section, that Jean Piaget did not produce pedagogical theories interpreting his scientific findings for classroom practices. These interpretations were made based on his work. This caveat is relevant, since pedagogical interpretations were not always produced with the same methodological concern as Piaget's initial research. Piaget.

3. In the original, the author refers to the expression "nature or nurture," which, in English, focuses on arguments related to the biological or cultural causes of learning, which, in Brazil, have been expressed around questions that oppose innateness versus learning. The authors of this article consider that both factors are relevant to understanding learning, and the balance between them is absolutely unique, for each individual, in any given situation. culture.

4. It is worth highlighting, in the item related to theories on intelligence, an important reference in the thesis on the themes of multiple intelligences (nine types of intelligence, a flexible number according to the author himself: interpersonal, intrapersonal, mathematical, corporal, linguistic, spatial, musical, naturalist, humanist (Gardner, 2005) and the constructs of neurodevelopment by Levine (2002, apud Tokuhama-Espinosa, 2008), describing eight of these constructs in the human brain (memory, attention, temporal sequential order, spatial order, language, neuromotor function, social cognition and order cognition). higher).

5. While not desirable as a general rule of learning, it is undeniable that some content requires memorization, and this varies across fields. For example, biologists work with an extremely designative type of knowledge, due to the evolution of the profession, which Howard Gardner (2005) described when highlighting naturalistic intelligence. Throughout the evolution of the species, they needed to categorize edible plants, for example, through visual identification and corresponding designation. Another area that necessarily involves memorization is language learning. or the training of actors. In that sense, and necessary recover the training from the memory, in instructional projects where this is necessary, without representing a paradigmatic heresy in relation to the construction of the knowledge.

6. Cognitive Sciences: “(...) new area that repositions the biology of perception and information processing (Cognitive Neuroscience) in dialogue with the

knowledge models that allow automatons and software to infer decisions and trigger virtual or mechanical behaviors (AI and Logic); with the cultural variables that influence the fundamental beliefs and values of learning (Anthropology); with the cognitive-emotional variables that influence the structuring of each individual's endogenous knowledge (Psychology); with the general representational characteristics of the species and specific to each professional or educational environment (Linguistics); and with the reflective and interpretative capacity of the human mind, to seek an integrative meaning of the process of production and categorization of knowledge (Philosophy)", (Timm et al., 2007).