

COGNITIVE SCIENCES AND EDUCATION: A PROPOSAL FOR DIALOGUE

Ciencias cognitivas y educación:

Una propuesta de diálogo

*ADELA FUENTES CANOSA**

National University of Education, Azogues, Ecuador
University of Coruña, Coruña, Spain
adela.fuentes.canosa@udc.es
Orcid code: <https://orcid.org/0000-0003-3305-2010>

*JENNIFER PAOLA UMANA***

National University of Education, Azogues, Ecuador
jennifer.umana@unae.edu.ec
Orcid code: <https://orcid.org/0000-0002-1998-7402>

*ALICIA RISSO MIGUES****

University of Coruña, Coruña, Spain
alicia.risso@udc.es
Orcid code: <https://orcid.org/0000-0001-6955-363X>

*DAVID FACAL MAYO*****

University of Santiago de Compostela, Spain
david.facal@usc.es
Orcid code: <https://orcid.org/0000-0001-6230-0090>

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- * Master in Applied Psychology and Ph.D. student in Psychological Development, Learning, and Health from the University of Coruña (Spain). Since 2016, she works as a teacher and researcher in the area of Educational Neuroscience and Human Learning at the National University of Education of Ecuador.
- ** Doctor in Literary Studies from the Federal University of Paraná (UFPR). She has a master's degree in Hispanic Literature from the University of Guanajuato with a grant from the National Council of Science and Technology (CONACYT). She is currently a research professor at the National University of Education (UNAE) in Ecuador.
- *** Doctor in Psychology from the University of Santiago de Compostela (Spain). Professor of the Behavioral Sciences Methodology Area, Department of Psychology, University of Coruña (Spain). She specialized in research design and data analysis; preparation and analysis of tests, scales and questionnaires; psychological research via the internet; and psychology of attention.
- **** Doctor in Developmental Psychology from the University of Santiago de Compostela. Master in Clinical Gerontology from the University of Coruña. He has been a professor in the Department of Developmental Psychology at USC since 2010, teaching classes in the Bachelor of Pedagogy and the Master in Psychogerontology. He is coordinator of the Master in Psychogerontology at USC since 2020.

Abstract

In this paper, a transdisciplinary communication approach between cognitive sciences and education, as configured in 21st century, was taken. In the first place, these communicational processes are contextualized inside the historical continuum that transits since the beginning of the last century, with the emergence of educational psychology within the construct of educational sciences; and the constitution of the cognitive sciences, in the mid-twentieth century, that led to the emergence of disciplinary synthesis between the brain and mind sciences. These previous steps enable a framework rooted in the present and in the proposals for consilience between education and cognitive neuroscience. From this historical present, a dialogue between the different epistemes (educational and cognitive), in relation to the phenomenon of bilingual education was made through its concretization in the Ecuadorian intercultural context. The different levels of analysis implicated in a complex phenomenon, as is all educational phenomenon, reflects how transdisciplinary approaches could enable the recognition of the ontological complexity that underlies in an object of study. The dialogue among the different epistemologies and methodologies involved was expressed through the opening of the educational field to the mental and cerebral dimensions in its cognitive expression. Our century, however, maybe is requiring processes of reciprocal openness regarding the influence that the culture-education axis exerts on the modelling of the processes of cognition and learning.

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Keywords

Education, cognition, psychology, neuroscience, bilingualism, culture.

Resumen

En este trabajo se realiza una propuesta de comunicación transdisciplinar entre las ciencias cognitivas y la educación, tal y como se perfilan en el siglo XXI. En un primer lugar se contextualizan estos procesos de comunicación en el continuum histórico que transita desde los inicios del siglo pasado, con la configuración de la psicología educativa dentro del constructo de las ciencias educativas; pasando por la constitución de las ciencias cognitivas, a mediados del siglo XX que propició la emergencia de la síntesis disciplinar entre las ciencias del cerebro y de la mente, para posibilitar un encuadre arraigado en el presente, y en las propuestas de consiliencia entre neurociencia cognitiva y educación. Desde este presente histórico, se efectúa una propuesta de diálogo entre las distintas epistemes (educativas y cognitivas), en relación con el fenómeno de la educación bilingüe, y en concreto en el contexto intercultural ecuatoriano. La integración de los distintos niveles de análisis que configuran un fenómeno complejo, como lo es todo fenómeno educativo, refleja cómo los intentos transdisciplinarios orientados a reconocer la complejidad ontológica de un mismo objeto de estudio, requiere del diálogo entre las distintas epistemologías y metodologías implicadas. La apertura del campo educativo a las dimensiones mentales y cerebrales en su expresión cognitiva, requiere en este s. XXI procesos de apertura recíproca respecto de la influencia que el eje cultura-educación ejerce en el modelamiento de los procesos de cognición y aprendizaje.

Palabras clave

Educación, cognición, psicología, neurociencia, bilingüismo, cultura.

Introduction

It is necessary to introduce and develop in education the study of the cerebral, mental and cultural characteristics of human knowledge, of its processes and modalities, of the mental and cultural dispositions that allow risking error and illusion
(Morin, 1999, p. 6).

This work proposes, through a critical review of the literature, to establish channels for dialogue between cognitive sciences and education expressed through bilingual education programs in the Ecuadorian context. The structuring of the results of the bibliographic review process calls for the establishment of a timeline, in which we can place the study of the question that refers to cognitive sciences and education. This timeline went back to the beginning of the 20th century, contextualizing the encounter of cognition and learning within the framework of the evolution from a monodisciplinary approach, to a multidisciplinary one within, the field of educational sciences and its interrelation with the disciplinary emergence of educational psychology. After this first section of the overview, it has been considered necessary to contemplate the historical moment of consolidation of cognitive sciences, in the middle of the last century, traversing the trail of the synergy of two of the essential disciplines in the study of human cognition, cognitive psychology and neuroscience, and the resulting product of this synergy, cognitive neuroscience. Subsequently, the emergence process of new disciplines will be addressed as a result of the consilience between cognitive neuroscience and education that originated at the end of the last century. Once the relevance of the relationship between cognitive sciences and education has been historically located, we will explore in depth of one of the aspects that have been considered essential in regard to the possible contributions that the cognitive sciences of the 21st century may be offering to the educational field: bilingual education. Its concretization in the Ecuadorian context, defined on its cultural and linguistic diversity, makes it necessary to consider the phenomenon of diglossia present in the scenario of Intercultural Bilingual Education (IBE). Subsequently, an attempt was made to establish a dialogue between the different areas of knowledge, offering a cognitive reading of the bilingual phenomenon, and complementing it with the views from the involved educational fields, to finally proceed to the presentation of the conclusions.

Cognitive science and education

Although the relationship between education and cognition today has been consolidated in the form of an indissoluble binomial, the materialization of the bridges or channels of communication between both fields of knowledge has historical channels that are expressed at different moments in educational history in which transversely, essential issues within the field of educational philosophy underlay. The processes of inter- and transdisciplinarity, which characterize the epistemic *Zeitgeist* of the sciences in the 21st century, bring with them the challenge of a rethinking of academic and investigative identities constructed on the basis of very defined limits. Overcoming these limits has been one of the crosscutting leitmotifs in the relationship between cognitive sciences and education in each of its stages. In the case of cognitive sciences and education, in its early stages, this openness is reflected in the educational consideration of the mental and brain levels at which learning and cognition take place; requiring, from later stages, a reciprocal opening of these levels, to the cultural and educational dimensions.



(1900-1950): Psychology and education

The explanation of the need to establish a close relationship between cognitive sciences and education constituted a central nucleus of the educational debate during the early 20th century. It was in the academic context of the University of Geneva, where proposals for a dialogue between the areas or departments of child psychology and experimental pedagogy will emerge. As Hameline (1993) argues, during this period, the keys for the evolution of an educational approach focused on the singular pedagogical discipline, towards the multidisciplinary product reflected in the plural terminology in force today, educational sciences, were forged. After this stage of intense debate, around the need for synergy between those areas of knowledge oriented towards the study of teaching and those focused on the study of learning, the creation of the Institute of Educational Sciences in Geneva was promoted, in 1912. As Hofstetter (2012) points out, this project offered testimony of the phenomenon of pedagogical effervescence that made possible the implementation of a project aimed at applying some principles of psychological training in teacher training curricula and laying the foundations for progress and development of an educational science that effectively integrates the contributions of the sciences of cognition and learning. The educational sciences anchored their beginnings in the monodisciplinary field of pedagogy or

educational science. However, the inherent complexity that characterizes educational phenomena will produce a need to cope with their object of study that integrates those fields of study, focused on cognition and learning, promoting disciplinary hybridization conditions and the birth of the educational psychology. It is in this multidisciplinary framework where the sciences of teaching and instruction, in a Herbartian sense that would include pedagogy and didactics, and psychological and cognitive science, converge, or in the words of Piaget (1969):

Any didactic method or any teaching program, of which their application and results must be analyzed from an experimental pedagogy, involves problems in developmental psychology, learning psychology, or general intelligence psychology (p.15).

As Piaget expresses, the study of learning and human cognition constitutes one of the essential fields of knowledge for the construction of educational knowledge, disciplinary materializing that intuitive premise that expresses that all quality teaching praxis must start from the principles that articulate the human learning processes.

In *How People Learn: Brain, Mind, Experience, and School*, the National Research Council (1999) places the origins of the scientific study of human learning in a parallel path to that of psychology and its establishment as a scientific discipline for the study of the human mind. It will be within psychology where the main scientific conceptions about learning emerge, basing, through educational psychology, its expression in the educational field. Castejón et al. (2013) express that educational psychology occupies a singular disciplinary space, positioning itself, at the same time, as a branch of knowledge of psychology and as one of the members of the multidisciplinary construct of educational sciences: educational psychology constitutes a bridge discipline between the fields of psychology and those of education and therefore, between cognition, learning and education.

One of the main objectives of educational psychology, in its initial stages and disciplinary consolidation, was to appeal to the need to adopt a scientific approach in which to frame the study of the educational phenomenon, fostering its roots within the field of educational sciences. Coll (1991) and Mayer (2001) refer to how educational psychology has been emerging as one of the key disciplines for coping with some of the essential problems for curriculum design; for various aspects related to the teaching of the different areas of knowledge that make up the educational curricula, as well as for the teacher training programs. This expansion of

the discipline, and its key positioning within the educational field, led to the blurring of its identity limits, a product of that disciplinary hybridization process that conforms it based on the integration of psychological and educational genes. Mayer (2001) states: “It is not easy being an educational psychologist these days. For our psychologist colleagues we are too educational (...) and for our educational colleagues we are too psychological” (p. 83).

The establishment of bridges between the mind and education, and the expression of its operability through educational psychology, profoundly marked the development of educational praxis and theory in the 20th century. The different theories about learning and human development were also expressed in the form of the pedagogical models that shaped the history of education during the last century (behaviorism, constructivism-cognitivism, and humanism): the development of the psychology of education and its evolution in the conceptualization of the mind and human behavior during the learning processes, were naturally translated into the multiple dimensions that make up the educational act, integrating themselves into the processes of construction of pedagogical and didactic knowledge.

The mind-education bridge, expressed through the birth and consolidation of the discipline of educational psychology, offers a model for understanding how the study of cognition and learning is rooted in the origins of the shaping of educational sciences, offering a solid testimony of the need to adopt plural points of view when facing a complex object of study, such as the educational phenomenon. Gordón and Arellano (2014) argue that this disciplinary bridge offers an example of the evolution of the educational framework through the convergence between the different psychological currents and educational theories, expressing themselves both in curricular structuring-implementation processes based on age or stage of student development; as in the design of didactic and instructional materials, or the evaluation of the most optimal methodologies for the full development of student capacities and potentialities.

(1950-1970): Cognitive psychology and neuroscience

The cognitive sciences, or cognitive science, since the nomenclature varies according to different sources, would be defined through the interdisciplinary study of the mind and intelligence, integrating the study that emerges within the areas of knowledge of philosophy, psychology, artificial intelligence, neuroscience, linguistics and anthropology. Although its



intellectual origins may be located in the mid-1950s, Gardner (1985) and Thagard (1996) indicate that it was necessary to wait for researchers and academics from various fields to begin to develop theories of the mind based on complex representations and computational procedures, locating its organizational origins at the end of the 70s, when the Cognitive Society was created and the Journal Cognitive Science was founded.

The interdisciplinary project of the cognitive sciences, with cognitive psychology as one of its root disciplines, did not crystallize in a fluid manner in the interrelation between the set of integrated disciplines. Crick and Koch (1998) explain that in the founding stages of cognitive sciences, the brain was conceived as if it were the human mind from the behavioral approach: as a black box that needed to be kept closed. Cognitive psychology, in this sense, was self-defined based on overcoming the behaviorist paradigm, to focus on the study of activity, and the role of the subject as a constructor of that same cognitive activity (Andrade, 2006). However, the consideration of the need to incorporate the biological dimension of this subject of cognition was not recognized in the initial stages of cognitive science.

In this sense, O'Brien (1991) points out that the development of the relationship between neuroscience and cognitive sciences constitutes one of the central topics of discussion during the initial stage of the emergence of cognitive sciences, and already in 1948, and in the context of the *Hixon Symposium*, held on the campus of the California Institute of Technology, scientists from various areas of study gather around the discussion of the possible relevance that the investigation of brain mechanisms and human behavior could have in the field of cognitive science. The integration of brain studies in cognitive science was characterized by the assignment of a secondary role to neuroscience, which, as Gardner (1985) refers to, was defined as a borderline discipline, or as Miller and Gazzaniga (1984) point out, as a support discipline, confronting it, in some way, with that set of root disciplines that made up the cognitive sciences: psychology, linguistics, artificial intelligence, and computational sciences. In this sense, Crick and Koch (1998) state that, although cognitive scientists, in opposition to behaviorism, claimed the need for the explicitness of models of mental processes, there was not a generalized enthusiasm in integrating brain studies, producing a split between those positions that advocated emphasizing the understanding of structural facts integrating the neural level, and those that defended the need to reluctantly face the integration of the biological level of analysis in the construction of cognitive science theories. Gardner (1985), referring to



the relevance of neuroscience for cognitive science, indicates: “Perhaps we can get to know each of the brain connections involved in the formation of concepts, but this will not help the understanding of what a concept is” (p. 286).

Gardner, through these words, directly alludes to one of the cracks that emerged between the set of disciplines that made up the construct of cognitive sciences, referring to the connectionist approach that prevails in brain studies and contrasting it with the symbolic models inherent to the approach, predominant in the cognitive psychology of the time. Marr (1982) examines different issues associated with the difficulties for the integration of the neural level within the cognitive sciences. In any study that refers to cognitive processing, there would be three levels of analysis. A first computational level, which alluded to the primary task carried out by an individual or system; a second algorithmic level, which would describe each of the steps carried out to carry out said task, and a third level, or implementation level, which would collect the mechanisms carried out by the hardware that makes it possible to carry out said algorithm. Byrnes (2001) highlights the fact that a normalized pattern in the construction of theories about mental events, during the time of the emergence of cognitive sciences, was to operate at the computational and algorithmic levels without considering it necessary to contemplate the level of implementation. O’Brien (1991), Stillings et al. (1995), and Lachman, Lachman, and Butterfield (1979) agree that in the theory of information processing, emerged within the cognitive sciences, the computer was the central metaphor for the study of mental activity. As Neisser (1967) indicates, cognitive science adopts under this prism a computational model of thought (with a strong emphasis on linguistic aspects) conceived based on the manipulation of symbols based on given rules. Stillings et al. (1995) and Bechtel (1994) allude to the fact that this symbolic model of information processing, to which the study of the mind adheres in the framework of the initial stage of cognitive sciences, outlined essential incompatibilities with the approach in which brain studies are ascribed since these classical symbolic models could not be explained at a neural level, framed in connectionist models or neural networks.

As the process of evolution of cognitive sciences was promoting the overcoming of the mind-computer metaphor as the central focus for the theoretical development of mental processes, the connection between cognitive psychology and neuroscience was strengthening, reflecting the need to integrate the levels of the brain in the study of human cognition. In this regard, Mayer (1981) defines cognitive psychology as the scienti-



fic study of the mental processes and memory structures of the human being. Gazzaniga, Ivry, and Mangun (2009) define the disciplinary synergy of cognitive psychology with neuroscience, cognitive neuroscience, as the study of mental processes and the biological aspects that underlie cognition: the mental processes that underlie cognition, and therefore in learning, they will be faced from the integration of the biological and psychological levels. Just as Albright, Kandel, and Posner (2000) express, human cognition in its mental, behavioral, and cerebral dimensions, stands as the object of study of cognitive neuroscience, and in this sense Mayer (1996) collects the proposal to equate the mind as a processing system –Hardware– cognition as the application –software– of cognitive processes, and learning as an acquisition of knowledge –data– will have to integrate a new element: the human brain. Regarding the disciplinary emergence of cognitive neuroscience, and anecdotally, Mclelland and Ralph (2015) place the coining of the nomenclature in 1979, during a taxi trip through New York City, and with George Miller and Michael Gazzaniga as protagonists. The birth of this new area of knowledge was caused by the convergence of various factors, Roche, Dockree, and Commins (2009) underline the importance of three events: In the first place, the fact that cognitive psychology took over from behaviorism starting in the 1950s, providing cognitive models and experimental methods for the study of human cognition; secondly, they highlight the fact that experimental neuropsychology, during the 50s and 60s, began to integrate the neural level in the studies of cognitive processing in patients with brain injury and neurological damage; Lastly, they emphasize the relevance of the advances in radiography and electroencephalography techniques that allowed the observation of the metabolic and electrical activity of the human brain during the performance of cognitive tasks. Hardcastle (2007) states that cognitive neuroscience is actually a really complex field that came to integrate different areas of research in cognitive psychology and neuroscience: brain development, perception, action, memory, higher cognitive functions, and brain plasticity.

Cognitive neuroscience is emerging today as one of the most prolific cognitive sciences of the late 20th and 21st centuries, its gradual foray into the fields of research on educational learning led to the emergence, during the 90s, of a debate around the need to integrate the brain level in the processes of construction of educational knowledge. Old questions, arising during the emergence stage of the bridges between mind and education and between mind and brain, were recovered, this time in the form of the triad consisting of mind, brain, and education.

(1990-): Cognitive neuroscience and education

On January 1, 1990, by presidential declaration, the ‘brain decade’ was established in the United States. In 1991, non-invasive neuroimaging techniques, such as functional magnetic resonance imaging (fMRI), began to be applied in humans. The study of the brain and human cognition, with the appearance of this type of non-harmful techniques, shifts the focus of interest from the study of the pathology of the central nervous system to the healthy brain: research in cognitive neuroscience is oriented, during this stage, towards the evaluation and localization of brain function in healthy individuals, producing an explosion of publications in this research field. As Jones and Mendell (1999) collect, this presidential proclamation marked a before and after in the area of neuroscience through public recognition and the consequent reorientation of the focus of the media towards the results of neuroscience research. The number of scientists attached to the Society for Neuroscience also increased exponentially, with a growth of more than 1000 members per year during this decade. Associated with the proclamation of the decade of the brain, the phenomenon known as Brain Mapping arises, which marks the beginning of the brain mapping project that is still in force today. In 2012, more than twenty daily articles focused on cognition and the human brain were published, and during the first decade of the 21st century, more than 100,000 articles were available in the U.S. Pubmed database (Savoy, 2001; Unesco, 2013).

It was during the last year of the decade of the brain when the proposal to integrate the results of research in cognitive neuroscience in the construction of educational knowledge was made official, expressed through the Brain and Learning project sponsored by the Organization for Economic Cooperation and Development-OECD. As results associated with the project, two reports are published (OECD, 2002; 2007) in which the birth of a new science of learning was proclaimed.

Proposals for a rapprochement between cognitive neuroscience and education became official in the academic field in 2001, in the Harvard University scenario, and in the form of a project based on the diagnosis of the need to update teacher training by incorporating literacy processes basic in neuroscience. The course was taught, among others, by two academics who actively participated in the consolidation process of cognitive sciences carried out in past decades, Kurt Fisher and Howard Gardner. This proposal evolves through the creation of the International Mind, Brain and Education society and with the inauguration, in 2004, of

the editorial body associated with this line of research, the *Mind, Brain, and Education Journal* (Blake & Gardner, 2007).

After the incursion and expansion into the academic field of the USA, the proposal reaches European territory, settling in different universities in the British territory and later expanding to different enclaves with variations in their nomenclature: mind, brain, and education; educational neuroscience; neuroeducation; neuropedagogy, or neurodidactics, are some of the terms with which it refers to the academic and research area settled at the intersection between education and cognitive neuroscience.

These new academic proposals can be conceptualized through their historical parallelism with the disciplinary emergence processes of educational psychology and cognitive neuroscience. In the current case, the proposal to incorporate the level of biological analysis in the construction of educational knowledge has met and still finds reluctance today: the recognition of the place that educational neuroscience (and its aspects in nomenclature) finds within the multidisciplinary construct of the educational sciences, continues to be questioned.

In this sense, it is observed in the present, the need for a synthesis between those exaggerated reductionist positions and those that are positioned at the opposite extreme, advocating the convenience of the exclusion of the neural and biological level. If you want to achieve a complete vision of a phenomenon as complex as education, it is necessary to integrate, in a non-reductionist framework, the cultural, social, affective, mental, and neural dimensions, seeking the understanding of the ways in which they interact; the integration of a new level of analysis, in this case, the biological one, responds to the needs that are denounced from the paradigms of complexity.

Just as Kim (2012) specifies, in the case of cognitive neuroscience and education, the combination of mental and neural levels in the study of learning fosters a process of reconceptualization of it, which needs to cross disciplinary boundaries to achieve a more comprehensive and complete vision. Koizumi (2004) also points out, with respect to the human biological system, that learning constitutes a process of increasing negentropy, or negative brain entropy: stimuli from the environment, in a specific period, promote the emergence of connections and brain circuits that remain in the time. Learning experiences, therefore, directly influence neural connection patterns both through the creation of new connections, as well as the strengthening of those most active networks, or the weakening and elimination of those that are not activated during contact with the experience. In this way, brain connections are gradually



modified in response to learning, and these changes, dependent on experience, would in turn affect the nature of later learning. In this sense, the inclusion of the brain level seems to appeal to the revision of the static visions of the cognitive potential or of the learning capacity, and also, in a certain sense, of a genetically determined human intelligence.

These a-dynamic conceptions reflect, to some degree, an incompatibility with the plastic capacity of the brain, as Hinton, Fischer, and Glennon (2012) indicate, as the human being learns, both in formal and informal contexts, learning experiences go on modeling brain architecture and configuring the learner's cognitive abilities. Gallistel and Maltzel (2013) emphasize that cognitive abilities in the framework of the cognitive sciences of the 21st century are conceived as something in continuous development and that the educational environment, consequently, would play an active role in the modeling of the structure and brain function: processes that become determined at the intra-subject level underlie all cognition and learning processes, but that same level reflects an openness to the environment and experience that is expressed through neural reconnection mechanisms that configure and reconfigure the learner's nervous system through of a retroactive dynamic with learning experiences.

For example, Calvo (2019) indicates that in the study of cognition and learning it became necessary to overcome simple visions and become aware of the need for this complex exchange between the inside and the outside. Both the learning capacity and the intelligence that defines the human being as a species, to form and reach its maximum potential, depends on the interaction of genetic factors with those associated with contact with experience. The human individual, from birth, is immersed in a socioculturally determined context and this context constitutes one of the main influences that will shape the individual's development process.

Nisbett and Masuda (2003) and Domínguez et al. (2009) contemplate how cultural influence would also be expressed in the field of cognitive functioning of each of the cerebral areas, both cortical and subcortical, which would respond both functionally and structurally to the flow of cultural experience, encompassing both the basic and the superior levels in cognitive processing and expanding to the affective and social spheres.

Nowadays it can be affirmed that at a global level, within our cultures and societies the process of universalization of education in its basic and elementary levels has been practically completed, Eccles and Roeser (1999) point out that the school constitutes a multilevel context of influence in the processes of socio-emotional and cognitive development, exercised through organizational, social and instructive processes. The



classroom is outlined as a setting intentionally designed so that those socio-politically determined learning processes are expressed through the curriculum and can be experienced. In this sense, from educational neuroscience, and from one of the central topics that articulate its object of study, educational neuromyths, the phenomenon of the proliferation of wrong beliefs regarding bilingual education has been collected, analyzed from its cognitive dimension. However, bilingualism constitutes a complex phenomenon, which not only encompasses the cognitive dimension, in which dimensions associated with social, cultural, and political levels transversely operate, which must be taken into account for the establishment of a true dialogue.

The Intercultural Bilingual Education Curriculum in Latin America and Ecuador

Intercultural Bilingual Education (IBE) in America could be thought of from the evangelization of Europeans in the New World since the empirical uses of the colonizers were directly related to the construction of didactic and linguistic material that allowed them an effective communication with the inhabitants of the new lands. However, its study and definition focus on the 20th century. According to Barnach (1997), during the first three decades of the last century, in different regions of the Andean highlands and the Mexican region, experiences of self-managed projects can be traced: in Bolivia, the Ayllu de Warisata school; in Ecuador, the schools created in the Chimborazo region; in Peru, schools located in Puno and, in Mexico, a country with more tradition in regard to bilingual education, different pioneering schools that sought to integrate the knowledge of ethnic minority populations that was excluded by the official education system; as stated by López (1998):

The Latin American scientific heritage has some studies dating from the first decades of this century, which, unfortunately, we have not bothered to recover and learn about and which, voluntarily or involuntarily, specialized international literature has been in charge of silencing (p. 51).

Therefore, studies around IBE have been prolific for the last forty years. However, in Mexico, studies around this issue date back to the 20s and 30s, in which different criticisms can be read towards the ignorance of these projects and their incidence within educational innovation and recreation. There is no doubt that this lack of interest in studies around intercultural education is directly related to racial, social, and linguistic

prejudices towards indigenous and afro peoples who sought to make their way into a westernized educational environment, being able to ignore their ancestral roots and traditions. Thus, the educational movements that emerged from the ethnic territories sought to re-construct teaching methods according to the community context and that claimed their own exercises as axes to combat school failure and the shame that came from recognizing oneself as indigenous or afro in contexts as global as those imposed by State policies, which saw ethnic relations and indigenous languages as an instrument to reinforce and impose hegemonic languages such as Spanish and English.

As is known, bilingual education had its beginning in integrative and assimilative models that sought, through the linguistic integration of minorities to the dominant communicative context, to create cheap productive forces that would respond efficiently to the various dynamics of power without reacting or opposing. However, it must be recognized that the dominant approaches around IBE and the attempt at linguistic impositions allowed the communities to carry out an evaluation that would determine the progress and restructuring within the educational exercises and the policies built around it.

Thus, the advancement of bilingual intercultural education in the American territory, according to Delia María Fajardo Salinas (2011) in her text *Bilingual intercultural education in Latin America: a brief state of affairs* occurred in three stages:

A first stage of transitional bilingualism; a second in which it drifts towards the maintenance of bilingualism, but without disappearing; and a third where other variants derived, in turn, from the maintenance of bilingualism are developed: intercultural bilingual education and ethnoeducation, among others (p. 2).

Although, the different stages sought the consolidation of education according to the territories, only until the end of the 20th century a consolidation, application, and operation can be observed in which education begins to be thought from a transition that tries to move away from cultural assimilation and restoring their own linguistic and cultural systems, which although it is carried out from a comparative structure with the dominant society, seeks to educate from the community referentiality that reinforces the own language and that is related to the values and own knowledge that dialogue with the Western and traditional culture in favor of the construction of a universality of contemplating the different conceptions of equity and cultural pluralism.



In this framework, the teaching and use of indigenous languages play a predominant role within the teaching-learning processes, since it is a communication instrument that is interrelated with the linguistic interaction of Spanish as a language of intercultural relationship, which, within the communities, expands the stylistic and lexical processes that include poly-functional exercises around the development of an educational component suitable for the diversity of the Latin American territory, in general, as well as for the specific Ecuadorian case.

Language in the IBE system is established as a primary element in educational processes. From the first grades or from Community Family Early Childhood Education, it is understood that linguistic exercises and communicative interactions must be given through the mother tongue, which, in this case, should be the language of the nationality, with which the teaching processes and learning should not go through translating exercises and should seek to integrate the linguistic codes in relation to the learning of the second language, in this case, the Spanish language. This linguistic interrelation seeks a communicative functionality without interference, which allows to identify and understand in their entirety different cultures one's own and universal, allowing the adoption of an epistemic diversity that allows the practice of an interculturality and transmission of knowledge, traditions, and ancestral customs that are not they are alien to "scientific" knowledge but rather integrate it into their knowledge processes or phases.

The Model of the Bilingual Intercultural Education System (MOSEIB) (Secretariat of the Bilingual Intercultural Education System, 2019) proposes the application of the educational model through the following steps:

- a) Recognition: Previous knowledge that the learner possesses and that is detected through different diagnoses.
- b) Knowledge: Creation and formation of new knowledge through investigative interaction carried out and mediated by the teacher and constructed by the students.
- c) Production: From scientific interaction with the environment and theories, the student builds new knowledge and puts them into practice in order to demonstrate empirical functionality.
- d) Reproduction: The learner interacts with what has been demonstrated and learned in order to improve and verify the processes developed.
- e) Creation: Based on the teacher's guidance and through individual imaginative uses, students build new ways of interacting and demonstrating knowledge.

- f) Recreation: It seeks to improve creations and overcome the processes of realization and empirical interaction.
- g) Validation: The theoretical and scientific advances around what has been studied are socialized to the local and educational community.
- h) Assessment: It is related to a double process in which the learner receives feedback from his educational process and from the generation of new knowledge in order to understand the useful purposes of learning and its use in certain social, cultural, and political contexts.

However, the model, despite taking into account the plural contexts of the Ecuadorian reality, does not adapt to the linguistic reality of the territories and communities, since they go through processes of linguistic regression and diglossia that hinder the effective implementation of the theoretical and philosophical precepts, generating an educational globalization that bases its teaching-learning on the practice and study of the Spanish language, avoiding linguistic revitalizations and reinforcing the monolingual use, which has generated the imminent extinction of indigenous languages and knowledge, since the community members consider that the use of their own language generates rejection and discrimination within mestizo society. This linguistic prejudice towards their own language has resulted in phenomena such as diglossia, in which the interference of Spanish and indigenous languages constructs intermediate or interlanguage languages that, at a certain point, end up creating more problems than reinforcements, thinking from the capacities generated by the ability bilingual.

Cognitive sciences and bilingual education, a proposal for dialogue

The close interrelation between cognitive sciences, bilingual education, and diglossia was expressed during the 1960s in the United States, and associated with the massive arrival of immigrants from other American enclaves, making explicit the need to adopt governmental measures for the integration of this population group in the North American public educational system. Padilla (1977) highlights how in 1965 policies for Bilingual Education were formulated in the United States through the Politic Bilingual Education Act (Title VII), which, as Beykont (2002) points out, was accompanied by a high degree of academic failure of participants. This fact led to the establishment of the belief that bilingualism was a cause of mental confusion in learners, and of inhibition



of the cognitive and academic development of students from minority cultures. Diamond (2010) alludes to the fact that the erroneous inference of correlations between bilingualism and cognitive development produced the proliferation of the premise that advocated the need for subjects to learn a single language, the majority (in this case, English) from childhood, ignoring the influence of other variables that could be leading to school failures, such as the model chosen for the implementation of bilingual education (which did not contemplate the cultural dimension) or the economic status in which minority groups were assigned. After this supposed failure of bilingual teaching, radically monolingual positions emerged that were legitimized through the appeal to cognitive foundations. A fundamentally diglossic conception of language learning was filtered through them. The dominance of a majority language, associated with a monocultural conception in the construction of national identity, sought refuge in supposedly cognitive premises to consolidate a position of monolingual dominance in the educational system.

The cognitive sciences of the 21st century, in this sense, as well as Park and Huang (2010) recollect, show evidence of the need for educational decision-making processes that respect the synergistic nature that describes the natural interrelation between culture, language, and cognition: sustained exposure to a type of experience, determined by the cultural context, is correlated with functional and structural changes in the brain, and it can therefore be deduced that continuous exposure to a specific cultural environment could affect both structure and functionality neural of the subjects. Rosenbaum, Weisler and Baker Ward (1995) indicate that this neural modeling, via culture, could be reflected, for example, in information processing models linked to the cultural values and beliefs that define East and West and producing different patterns: more focused on the object and on the organization of information through laws and categories — western culture— and other more global ones, where the object and context would be processed in a unified manner and relational information would be prioritized over the categorical — eastern culture—.

Sui, Liu, and Han (2009), Zhu et al. (2007), and Sui and Han (2007) refer to the fact that these differentiated types in information processing could also be expressed in the configuration of the individual self with respect to relational patterns for the configuration of the non-self, or otherness: culture affects the psychic structure of the self and results in two different types of self-representation, an independent self, characteristic of Western culture, and an interdependent self, characteristic of Eastern culture. Kitayama and Park (2010) allude to the fact that the human brain and

mind would come biologically prepared, complemented, and transformed through the active participation of the human being in the eco-symbolic environment called culture. Downey and Lende (2012) point out how the human nervous system has a disproportionate susceptibility to cultural modeling and the nurturing environment of an individual, affecting the environmental niche in which our nervous system is modeled.

One of the expressions that define human cultures is language, defining at the same time the essentiality and specificity of human cognition. Just as Castillo (2004) emphasizes that the so-called ancestral languages, such as the Andean languages, reflect differentiated features in cognitive categorization processes with respect to those with which they coexist, such as Spanish, which is inscribed in Western cultural models. An example is the one that is ascribed to the linguistic category of number, which indicates the reference to either a single object or a plural one, which in the Spanish language is conceived based on relational categories of exclusion; In the Quechua language, however, the relational category is dialectical, recognizing the existence of two types of plural, two types of “we,” one general or universal, and the other exclusive. In this sense, Godenzi (2014) indicates that the grammatical and syntactic categories of the Andean languages respond to specific symbolic conceptions in which to frame the construction of reality (complementary coexistence, separation and the encounter of opposites, inversion; symmetric, asymmetric and recursive reciprocity...).

Decision-making around the implementation of bilingual education programs should take into account these cultural aspects, ascribed to language, and that directly influence the cognition of the subjects. As Padilla (1977) expresses, every bilingual education project is determined by specific philosophical principles: that of ‘cultural assimilation’, in which the native language is instrumentalized as a tool to bridge the gap between home and school and that it should gradually be replaced by the majority language without taking into account aspects of cultural integration in the design of curricula; that of ‘cultural pluralism’, based on equal rights between different languages and cultures, advocating the indissolubility of the language-culture binomial, and that of ‘cultural separation’ in which bilingual problems are addressed through educational segregation of the subjects from the minority culture.

Beyond the political and social dimensions that make up bilingualism, and with a focus on the cognitive dimension, cognitive neuroscience provides evidence of the advantages of learning and acquiring two or more languages during the vital development of the individual. As Cos-



ta and Sebastián Gallés (2014) state, the evolutionary trajectory of the acquisition processes of two languages is marked by the requirement of learning two linguistic codes (two phonetic systems, two lexical systems, and two grammatical systems), and consequently of the requirement to carry out specific computing processes that require the simultaneous existence of two speech systems, responding to the need for information processing in each of the linguistic systems: bilingualism affects brain activity associated with linguistic processing, as a result of the increase in the demands of that same processing.

Diamond (2010), Carlson and Meltzoff (2008), and Bialystok (1999) state that speaking and understanding several languages could lead to improvements that transcend exclusively linguistic domains, such as executive functions. However, Cormier et al. (2012) and according to what was hypothesized by Lenneberg (1967), there are sensitive periods for the acquisition of the mother tongue, and this fact is transferred to multilingual learning. Higby, Kim, and Obler (2013) and Hyltenstam and Abrahamsson (2002) point out that the human brain has the ability to adapt to the acquisition of more than one linguistic system and the age of acquisition of these systems could be a crucial factor in the level of competence acquired finding a turning point in the period after puberty. Kuhl (2011) expresses in this regard that the child has, from the first years of life, the ability to acquire all those languages to which it may be exposed, through much more flexible learning processes than those developed in adulthood, in which language processing is markedly modularized. Early learning of a second language would also operate as a resilience factor in the face of cognitive deterioration in the stages of old age. As well as Calvo et al. (2016); Kowoll et al. (2016), and Gold et al. (2013) indicate, bilingualism constitutes one of the factors associated with a higher level of cognitive reserve in the stages of old age, and with advantages in the processes of cognitive control in this same age group.

Conclusions

In the consilience proposals between cognitive sciences and education, there are cross-cutting issues in the philosophy of science. These proposals could sometimes be formulated from the classical division between the basic, or 'pure' sciences, and those conceived as applied sciences. Many of the criticisms made of the disciplines that have taken over the synergy between cognitive neuroscience and education are articulated based on

this precise dialectic: the lack of application in real educational contexts of the evidences that arise from the cognitive laboratory.

This type of approach could be constituting one of the main epistemological barriers so that consilience between academic fields can be expressed, configuring a trend of academic resistance within the educational area. Recognition of this tension is necessary, and could in fact be the engine of evolution for effective transdisciplinarity. Educational neuroscience, neuroeducation or neuropedagogy have the pending objective of an effective anchoring and laying roots in the educational field, accepting the complexity of their identity for the production of both basic and applied knowledge created in the intersection nucleus between education and neuroscience. The imbalance in the anchoring coordinates with respect to one or another area could relegate them to a 'no man's land', making it difficult to consolidate them within the multidimensional construct that configures the sciences of education in this century.

This pending lesson, however, also requires an open position in the educational academy, which sometimes seems to feel the threat of a reductionism regarding the mental and cerebral level of analysis, which could be expressed through the term 'neurophobia' (-phobia, would refer to its etymological root of fear). According to Ocampo (2019), the fear of the biological reduction of the essentiality of the levels of analysis that make up the educational act could lie in the fact that the synergy proposals between education and the cognitive sciences advocate a radical process of psychologization or educational neurologization ('neurophilia'). It could be affirmed, therefore, that somehow a dialectical challenge is emerging in its quintessence, with a thesis in favor of neuro-educational consilience and an antithesis that opposes it. The challenge becomes apparent in the same structural patterns that make up the dialectical dynamics, a synthesis is necessary, which, on the one hand, overcomes those naïve visions that placed neuroscience as the new panacea for facing educational problems (and that were expressed through the consolidation of educational neuro-mythology); taking into account, at the same time, the reluctance and skepticism of those who are directly opposed to any type of contact, to finally be able to reach the integration of both in a synthetic result.

In this sense, the epistemic compass that has guided this work is to be able to make a possible contribution to the delineation of this synthesis, expressed through a proposal for dialogue between the different fields of knowledge that encompasses the bilingual phenomenon in its educational dimension. The incorporation of the mental and cerebral levels to the educational knowledge processes would not per se have to constitute



a cause of reductionism. In *ex æquo* relationship patterns, it could, on the contrary, contribute to the achievement of a greater depth in the processes of understanding some dimensions of those essentially complex phenomena, such as educational ones, by integrating new levels of analysis.

Collado (2017) establishes that, if the incursion of cognitive sciences in the educational field is analyzed based on dynamics of complexity, in which the organization of knowledge is framed in non-hierarchical horizontal patterns, the introduction of these levels far from inviting a position in any type of reductionism, it would enrich the understanding of educational reality, a reality that is in fact intrinsically multidimensional. It is the awareness of this multidimensional nature, which defines education, that appeals to a confrontation of its study that contemplates the intricate interrelation of each of the dimensions that make it up, transcending the hierarchical patterns of relationship between fields of knowledge and therefore any type of reductionism or subordination between disciplines: the recognition of complexity carries in its germ the openness to the different and the re-questioning of disciplinary identities.

In this sense, and after having completed the route proposed in this work, exploring, on the one hand, the historical relationship between cognitive sciences and education, and, on the other, the history of the implementation of bilingual intercultural education programs, we have tried to cover those dimensions that make up the study of human cognition, but accepting the need to overcome reductionism, in the analysis of a specific educational case: bilingual education in the Ecuadorian scenario. The proposal for dialogue between the studies of cognition and the field of educational sciences is in itself a complex proposal, which requires the opening of the educational field to certain levels of analysis, such as cognitive; but at the same time, it demands a reciprocal opening of the studies of cognition to the culture-education axis, which shapes and, in this way, also defines the cognitive dimension of the human being. The cognitive sciences of the 21st century indicate that bilingualism, far from interfering with the learning capacity of the subject, modifies it in ways that go beyond linguistic processing. The commitment to bilingualism is in that sense, a good educational commitment, aimed at one of its essential purposes: supporting the development and learning potential of the subjects.

However, the history of educational implementation of bilingual education programs offers an example of how this fact has been ignored to justly defend the opposite argument or the convenience of a monolingual educational system mediated by historically determined and socio-political contexts in which the Diglossic conceptions operated in an un-



derlying manner. In the proposal for dialogue between cognitive sciences and IBE, it is emphasized that bilingualism reaches far beyond language learning (that is, it opens the dialogue to levels of analysis –beyond– language or trans-linguistic) and that historically it was mediated due to the imbalance between cultures and languages that coexist in intercultural and multilingual contexts. Any educational proposal in intercultural contexts must take this fact into account, becoming aware of the cognitive advantages offered by bilingualism without falling into aseptic conceptions that break the bond that unites language and culture.

In summary, the dialogue between cognitive sciences and education, in this specific case, affects the need to trace and explore each of the possibilities found in the intersection fields between the different types of knowledge that make up this dialogue. From the convergence of cognitive neuroscience and education, the topic of bilingualism has been analyzed offering evidence in favor of the implementation of bilingual education, however, if we want to advance in the debate, it is necessary to integrate new levels of analysis, such as that of the imbalance in the social and cultural valuation of languages that underlie some educational linguistic policies. This work, therefore, constitutes a proposal that appeals to the need for transdisciplinary communication to solve the complex problems that define the challenges of education in this new century, in which the tensions between different epistemes can be blurred with the purpose of offering the ontological understanding that education deserves.

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