NEW SCIENTIFIC SPIRIT AND NEW EPISTEMOLOGY: A MORE POIETIC POINT OF VIEW OF EDUCATION AND KNOWLEDGE

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ABSTRACT
The positivist science model has been influencing Education for more than three centuries. The belief that guides such model separates the intelligible world, as the most important, which, deals with science, intelligence and the brain from the sensitive world, one-step down in importance, which, deals with sensitive experiences and emotions. The application of such epistemological concepts helped to build the current education model. The current education conceptions indicate an urgency in seeking, not only new methodology theories, but also the construction of an educational concept more connected to modern times demands. The work of Gaston Bachelard is considered one of the most important regarding the twentieth century science revolution when it comes to a new creative poetic construction with several points of view. The following paper tries, briefly, to use the ideas presented by Bachelard in his book "The new scientific spirit" and relate them to the proposal of a poetic point of view regarding education and knowledge by setting a dialogue with other authors who developed their considerations from Bachelard as well.

Keywords: Education. Epistemology. Complexity. Bachelard.

UNDERTANDING THE CONTEXT

When it comes to classroom management, most teachers are used to seeing and perceiving the world and the learning process with a conservative point of view as well as having a positivist point of view towards science. According to Moraes (2004), such perspective sees reality as something structured, stable, predictable, and predetermined as well as rationality as the basis for knowledge construction. Positivism, a theory that has been influencing Education for more than three centuries, is a combination of various currents of thought influenced by the Scientific Revolution, Illuminism, and the Industrial Revolution. Positivism is a philosophical theory stating that positive knowledge is based on natural phenomena and their properties and relations. Thus, information derived from sensory experience, interpreted through reason and logic, forms the exclusive source of all authoritative knowledge. Positivism holds that valid knowledge (certitude or truth) is found only in this derived knowledge.

Such philosophical currents influenced other theories, which adopt different epistemological postures regarding knowledge and reality nature. Thus, science under the positivist perspective tends to separate the intelligible from the sensitive world:

> The intelligible world, the concrete one, is where the ideas, or the essence of things, are built as well as where science, intelligence, and the brain are. The sensitive world is where believes, opinions, sensitive experiences, and emotions are. (LANZARINI; GUSTSACK, 2014, p. 98)

Such distinction, first done by PLATO, influenced the formation of modern science (Descartes). Thus, the experiment must have the possibility of being verified, analyzed, synthetized, and numbered which makes it being accepted and seen as a method or experiment under a universalist perspective on science. Under the positivist scientific point of view, only the five senses (taste, sight, touch, smell, and hearing) are reliable to perceive the world and such perception uses rationality as a bridge to intellectual activities. Such thing determines reason as one of the distinct characteristics of human beings, which is their capacity of controlling and manipulating everything.

For Torres and Behrens (2014), educational systems (schools and universities) reflect such fragmented model, which break knowledge into areas, courses, subjects, and units, among others. At schools and universities...

> [...] it is taught to isolate objects (from the environment), separate subjects (instead of seeing their correlations), dissociate problems instead of putting together and integrate them. It is imposed to simplify things, and decompose instead of recompose as well as eliminate anything that affect or cause contradictions in comprehension. (MORIN, 2001, p. 15).

Such epistemological principles started being applied to social phenomena, ignoring the differences among such phenomena. Moraes (1966. P. 59) defines quite well the influence of such scientific model in contemporary education:

> It is a school that keeps segmenting knowledge into topics, specialties, subspecialties, centered on the teacher and still seeing students as a tabula rasa. It produces submissive, obedient, and castrated students when it comes to their creativity as well as other ways of expression and solidarity [...]

For Moraes (1996), the current education concepts show the urgency of seeking not only new theories and methodologies bases, but constructing a new educational concept in line with contemporary demands. Seen as one of the best studies on a new rationality within the twentieth century science revolution Bachelard:

> [...] brought to knowledge and science philosophy the revolutionary concepts of physics, relativity, quantum physics, and non-Euclidian geometry. For him, and his open and dialectic rationalism, reason and experience are poles of epistemology, a dualist base, but nor dichtomic neither exclusionary (ANTONIO, 2009, p. 76).

Bachelard (apud BARBOSA; BULCÃO, 2004, p. 11), "establishes a totally original epistemological view". He is credited the foundation of a new way of understanding epis-

temology by "showing its intrinsic connection to science history". Consequently, it feeds epistemology the data to its construction (BARBOSA; BULCÃO, 2004, p. 12). Thus, the following paper, even briefly, tries to display some of the ideas presented by Bachelard, connecting them to the proposal of a po(i)etic[1] view of education and knowledge. The authors used a literary review, which led to a comparison of Bachelard to other authors who based their ideas on him.

Due to its qualitative characteristic, the following paper has a bibliographical view based on the book "The New Scientific Spirit". Regarding the proposed objectives, it is classified as exploratory because it looks upon the education phenomenon through a different perspective, which considers Bachelard's proposals by connecting them to a po(i)etic view of education and knowledge.

NON-CARTESIAN EPISTEMOLOGY

For Bachelard (1974; 1985), traditional epistemology was completely inappropriate to handle late nineteenth century science when it comes to methods and procedures as well as concepts and theories. The effective science epistemology at that time, that intended to establish the observed phenomenon invariable laws empirically, was affected by the theory of relativity, quantum physics, and the non- Euclidian geometry.

According to José Carlos Bruni (2005), Bachelard used the word "NO" as his motto. No to fixed points, to established truths, anachronistic methods, to fossilized intellectual habits. (PAIVA, 2005, p. 13). Bachelard claimed that traditional philosophies from Aristotle (science is all there is), Descartes (simplicity of truth), and Kant (absolute determinism), were not enough for the new century. He (1974; 1985) believed that the twentieth century scientific thought should not be restrained to explain laws, and limit itself to transcribe information obtained in observations, but invent reality and question its own constitution. Such thought demanded some restlessness allied to imagination oriented to create an indefatigable search of what had not been said yet.

By choosing scientific thought as the object of his considerations, Bachelard (1974; 1985) conceived science as a procedural and unfinished construction where thought and experience are intertwined. For Bachelard (s/a *apud* Paiva, 2005), on one hand scientists were inept to handle science philosophy due to their limitation to considering only facts and experiment results, on the other hand philosophers who believed in an epistemology based on too broad general principles were wrong. Such philosophers sought, within science, elements to base their assumptions as well as examples that did not ratify their

1 The term "autopoiesis" (from Greek - (auto-), meaning 'self', and (poiesis), meaning 'creation, production') refers to a system capable of reproducing and maintaining itself. It defines the self-maintaining chemistry of living cells. Since then the concept has been also applied to the fields of systems theory and sociology. The basic notion of autopoiesis as involving constructive interaction with the environment is extended to include cognition where every human beings build themselves independently. Living and knowing are inseparable, which allows human beings to see life as a learning process. (MATURANA; VARELA, 1990).

beliefs.

> The first experience or, more precisely, observation is always an initial obstacle to the scientific culture. In fact, such observation is full of images. It is peculiar, concrete, natural, and easy. Its description is enough to seduce you. It seems you understand it. Let us start our investigation by characterizing such obstacle and showing that there is a rupture, and not continuity, between observation and experimentation. (BACHELARD, 1996, p. 25)

Regarding his critic to the positivist epistemology, Bachelard (2006) indicates the danger of generalization that after the first impression blinds the eye for a more accurate opinion. By developing his new scientific rationalism, he says:

> If one could philosophically translate the current scientific thought double movement it would be clear that the alternation between "a priori" and "a posteriori" is compulsory. In addition, empirism and rationalism are connected to the scientific thought by an unusual bond as strong as what connects pleasure to pain. Indeed, one of them stands out justifying the other. Empirism must be understood and rationalism must be applied. An empirism without clear guidelines, coordinates, and deduction cannot be taught. A rationalism without concrete evidences and real application does not fully convince. To make a reasoning legitimate it must be the base of an experiment. (BACHELARD, 1974, p. 162-163).

According to Paiva (2005), Bachelard's work reveals an effort to update science philosophy along with the attempt to set a new scientific spirit that sees science as an activity that evolves without linearity and whose principles are contingent, remaining connected to the historical moment in which they are made. Bachelard's epistemology ruptures with merely idealist, formalist, rationalist, empiricist, and positivist presumptions. The new mutant and innovative sciences, which constantly rupture with themselves, are going to produce a new science philosophy. According to him, "one of the indirect science creation is philosophy. The philosopher must be open minded to be able to express the contemporary thought in its flexibility and mobility".

Bachelard (1974; 1975) was emphatic in claiming that the new scientific thought should rotate among reason and experience, theory and practice, a priori and a posteriori as well as that science philosophy was a kind of applicable philosophy that could not keep the purity and consistency of a speculative philosophy. Whatever the scientific activity starting point was, such activity could not be fully convincing but rather leave the basis domain: "[...] if the scientific activity experiments, it is necessary to reason. If it reasons it is necessary to experiment." (BACHELARD, 1985, p. 12-13).

The new science epistemology, according to Bachelard (1974; 1975), would be guided by a useful interaction among reason and experience, realism and idealism, and empirism and rationalism. The philosophy Bachelard stood for is oriented by a science that rec-

ognizes itself as construction, and a path to the new, which takes place through theoretical effort and experimental investigation. Along with construction and evolution, it questions itself. It is a creative process, which goes from rational to real, since rationality and reality can influence one another when confronted.

Thus, the objective of scientific activity is no longer a nature data, but a phenomenon that must be created. Reality itself, before being considered as the investigation object, does not exist. "Its existence is proved with science, which instead of describing it, is going to invent and transform it" (PAIVA, 2005, p.42).

Finally, such new epistemology implies the possibility and skill for a constant change, capable of incorporating new knowledge and keeping focused on the fact that reason and experience are connected and relate to one another dialectally. Such dialectic, according to Bachelard, is always a knowledge dialectic, "a method that intends to reorganize scientific knowledge in a constant practice where theory and experience witness a mutual adjustment historical process" (PAIVA, 2005, p.38).

AN EDUCATION AND KNOWLEDGE PO(I)ETIC POINT OF VIEW

Throughout the twentieth century, according to several texts, the theory of relativity and quantum physics transformed the classic scientific point of view radically. Ecology has contributed to a new nature understanding where living beings are fully connected, interactive, and interdependent. Life started being seen as a knowledge reworking and self-organization. Knowing becomes an inseparable cultural and biological experience. According to Antonio (2009), it is an activity that creates things.

> For Bachelard [...] 'the progress of contemporary scientific thought determined the transformations of knowledge principles'
> [...] regarding knowledge details as well as general knowledge structure, contemporary science presents itself as an indisputable *novelty*. (SILVA, 1999, p. 119).

The urgency of new concepts of world, knowledge and education has not been linear and easy. Such concepts are based on movements originated before the twentieth century and that have been engendering several discussions, which criticize traditional positivist models within education. The traditional Cartesian school model impoverishes student's potentialities, wishes, and autonomy by promoting the massification of education for a greater good.

It seems that education has assimilated, even if in the twenty-first century, the need of rethinking the most fundamental concepts of understanding presumptions and relationships as well as pedagogical practices including lesson planning and teaching". (ANTONIO, 2009, p. 45). Most classes are planned by the automatic association between the parts and

the whole. Teachers rarely apply new interconnection, interactivity, and interdependence concepts as well as reciprocal and causality concepts neither when it comes to the content nor to the way to relate ideas and design reasoning, which would stimulate students to think. That is, several classes still follow the Aristotle-Thomism or Cartesian-Newtonian model, which means positivist practices.

Nowadays most people have access to a great deal of information, but it has never been so difficult to acquire knowledge. Information is just a tiny step to knowledge. Knowing, according to Moran (2012, p.41), is:

> [...] to relate, integrate, contextualize, and incorporate outer things. Knowing is to discover, and go beyond what is superficial, predicable, and exterior. Knowing is to go deep into the discovery level, things in general, the reality and oneself. Knowing is to try to reach wisdom and full integration, to perceive the great synthesis when one gets in contact with a new concept of "world", with people, and a deep look within oneself [...]

Such observation from Moran (2014) addresses to Morin (2002, p.58) when he says, "the human being is complex and has antagonistic bipolar characteristics", that is, wise and mad, worker and ludic, empiric and dreamer, thrifting and consumerist, prosaic and poetic. It means that humans are biological, physical, psychic, cultural, social and historical concurrently. Considering such ideas, it is obvious that education needs to rethink its guidelines. It is necessary to think differently to act differently, which means, learn to think again.

For Antonio (2009), emotion moves, literally and metaphorically, intelligence. Etymologically speaking, motto, motor, motive, and emotional are connected by the same linguistic root. Educating intelligence is inseparable from educating sensibility. Educating sensibility, perception, and feelings is essential for awakening the will for learning. Without awakening and developing such will, there will not be significant learning, knowledge building, and original ideas.

Knowledge is meaningful only when it means something for the ones who seek it. When it is experienced and critically thought, it becomes experience. As well as when it is applicable somehow somewhere. Knowledge is built from constant challenges that stimulate imagination, curiosity, and inventiveness. According to Silva (1999, p. 135):

> Thus, it is important to emphasize the non-attachment and non-sentencing of some specific knowledge and values, which can turn to a review and reordering of them. Then, school can built itself in a privileged and decisive position to practice such dynamics as well as to forge such posture [...]

Since school is a knowledge and value revisiting and reordering place, it is possible to say that beyond intelligence education, it is necessary to educate sensibility and imagi-

nation as well. According to Antônio, imagination is also part of knowledge, and without it, one cannot elaborate theories. Thus, imaginative capacity becomes more important than information itself.

For Bachelard (1986, p. xvi *apud* ANTONIO, 2009, p.77), "imagination is not, as etymology suggests, the faculty to form images of reality. It is the faculty of forming images that go beyond and describe reality."

The education in most schools focus on content, which tries to understand "reality" objectively and has always valued rationality (LAZARINI; GUSTSACK, 2014, p. 100). There must be a way to lead education to interact better with sensorial, emotional, intellectual, and ethical knowledge, because "[...] every knowledge at its initial formation is polemic and has to deconstruct before constructing its basis. The deconstruction takes place continuously but the construction never ends" (BACHELARD, 1994, p. 22 *apud* SILVA, 1999, p. 143).

In other words, it is necessary to invest in discovering, unexpected connections, junctions, overlapping, and non-linear navigation that go over predicable boundaries of what has been previously accepted from research. After all,

> [...] nowadays students do not need to go to school to seek information. If they went to school, just for that teachers would not be necessary because communication and information technology can provide information much more efficiently. Students go to school to interpret, relate, hierarchize, and contextualize such massive wave of information that reach them. Thus, the teacher's job is to aid them to question, seek new angles, and relativize the data in order to make them arrive at their own conclusions (LANZARINI; GUSTSACK, 2014, p.29).

"Information has uncontrollably spread over the latter decades and thus, teaching needs to focus on learning, mainly learning to learn (BEHRENS, 2012, p. 70). Such learning to learn process, according to Behrens (2014, p. 96),

> [...] it means to know how to make questions, observe, investigate, find information sources, and use ways and strategies that allow the analysis of the collected data, which means knowing how to choose what is relevant to find possible solutions for the proposed problem.

Such understanding on the need for a change in education contributed to the arising of a new paradigm called, by Boaventura Santos (1989), Moraes (1997), Pimentel (1993), Gutiérrez (1999); Behrens (1999) e Navas (2010), the Complexity or Emergent Paradigm. Characterize, in a few words, such paradigm is not an easy task, but it can be said that it arises from an alliance of constructivist, interactionist, sociocultural and transcendent approaches and "seeks a vision of the whole, the importance of learning and the reproduction surmounting of knowledge production" (BEHRENS, 2012, p.86). Even that initially it looks like a rupture and a completely new way of understanding educational phenomena,

in fact it is not.

> What the complex thought proposes is to integrate, unite, analyze, and synthetize and, concurrently, be aware of the temporariness and singularity of processes. Although learning conceptions, curriculum, the teacher role, and school organization, under a complex point of view, sounds as something new, in fact they are part of the pedagogical repertoire that education history passed on to us. That is, the complex thought applied to education and teaching practices do not replace methods, but it intends to recover exciting, creative, enriching, and liberating classroom activities in order to integrate and develop them from a new point of view. (LAZARINI, 2015, p. 25).

Regarding complexity, according to Morin (2001), learning is considered a self-eco-organized process. It is

> [...] a complex praxis that is the result of the interrelations of one with himself, with others and with the world. It involves the dimensions of the body, mind, and intuition that self-reproduce in reciprocity. Learning is the result of one's interactions with the environment where he or she lives. The changes within such environment might disturb one and lead to new characteristics of oneself. One's feelings rapidly catch such disturbances and make an effort to transform them into new learnings. Such new learnings change the environment and consequently reflect on individuals making a complex change and learning swirling (LANZARINI, 2015, p. 25).

Such paradigm challenges teachers to seek a practice that overcomes knowledge fragmentation and reproduction. It challenges them to rebuild their practice within the classroom making students cognoscente beings, appraising reflection, action, curiosity, critical thinking, and questioning. Thus, teachers can understand knowledge as something temporary and relative, worrying about the historical dimension of its construction. It might give rise to knowledge interpretation not only its acceptance.

> [...] teachers replace discoveries by classes. Against such intellectual indolence that suppress one's spiritual novelty sense, teaching discoveries throughout scientific history might be very helpful. To teach students to invent, it is advisable to teach them that they can discover. (BACHELARD, 1996, p. 303 *apud* SILVA, 1999, p. 152).

According to Moraes (2004), the principles and values of such new paradigm might induce to more dynamic, integrative, complex, and holistic pedagogical practices that require more conceptual understanding regarding learning knowledge and the complexity that involve such educational processes. There is a po(i)etic education and knowledge point of view. Such point of view, according to Antonio (2009, p. 14),

> [...] reveals a sensibility and intelligence reeducation, and in order to make it grow, it needs to be nurtured by new ways of feeling and thinking - including new ways of reasoning that are inserted within linear causality logic as well as by new teaching and learning, and living and living together.

When it comes to knowledge, conceived as a complex production activity, such new point of view understands the primacy of reality and context, and no longer abstraction and analysis. For Antonio (2009), it means to recognize the multiple dimensions of reality, connected and interdependent, that moves and transforms themselves. When it comes to education, conceived as sense creation and creating anew, such new point of view understands the primacy of scientific knowledge reconnection, sciences to themselves and to society, history and life, objectivity and subjectivity, and cognitive and affective. According to the same author, it means the primacy of interpretation and questioning, learn critically and creatively with personal ideas and words and significant dialogues. It is a denial to meaningless memorization, doctrines, and taming.

CONCLUSION

Every crisis is characterized as destruction and creation. Such epistemological change is still being daily gestated in movements that take place in several knowledge areas. It has been slowly built in a new epistemic matrix, a new understanding, a new "knowledge of knowledge" that has the reality complexity interdisciplinary recognition as one of its most significant characteristics.

Recognizing such new conception, the authors suggest to teachers the quest for a pedagogical practice that get along with the scientific thought that overcomes knowledge fragmentation and reproduction. It should go beyond the educational linearity process and conceive education as a self-po(i)etic flow and interconnection process. A creative, collaborative and self-contained process, which value questioning, reflection, action, curiosity, and critical thinking. It should be an educational process that would pave the way to subjectivity, emotion, intuition, and the acceptance of diversity. It should also be a place of tolerance to different points of view, and above all, a place for a better life for everyone on earth. That is why it is necessary to conceive knowledge as something temporary and relative where the main concern would be the historical dimension of its construction.

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