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PARADIGM OF COMPLEXITY AS AN EPISTEMOLOGICAL SUBSIDY IN THE TRAINING OF BASIC EDUCACION TEACHERS: a possible path

PARADIGMA DA COMPLEXIDADE COMO SUBISÍDIO EPISTEMOLÓGICO NA FORMAÇÃO DE PROFESSORES NA EDUCAÇAO BÁSICA: um caminho possível

PARADIGMA DE LA COMPLEJIDAD COMO SUBSIDIO EPISTEMOLÓGICO EN LA FORMACIÓN DE PROFESORES DE EDUCACIÓN BÁSICA: un caminho posible

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ABSTRACT:
Practicing teaching and being a teacher is not just about having information and mastering the technique, but also, thinking about the current context, understanding knowledge with meaning for social, local and global life, that is, knowing how to contextualize the knowledge and information to which we have access. With this, school education becomes fundamental in the contemporary world, and teachers are essential in this scenario, which requires training consistent with the needs of this new social context, with new postures and new ways of thinking about knowledge. In this sense, a paradigm that subsidizes teachers is necessary, and for this we agree with Morin (2018a), who indicates the need for a thought that unites and supports knowledge, bringing the wholeness of being.

KEYWORDS: Complex Thinking; Transdisciplinarity; Cognitive Operators.

Introduction

Nowadays, we have a very recurring speech declaring that we are facing the information and knowledge society. However, Morin (2013, p. 184) warns us that we are part of a "society of knowledge separated from each other", and this separation prevents us from reconnecting knowledge, prevents us from imagining local and global problems. This statement invites us to rethink our actions and how they can interfere in different contexts, since we are not isolated, but connected to our homeland (Morin, 2013). In this sense, according to Gatti et al. (2019):

> The educational practices of trainers, and in the future of those who are training as teachers, require new understandings, new relational stances and new didactics for activities in school environments and the construction of more effective pedagogical relationships in their meaning (Gatti et al., 2019, p. 38).

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Thus, it is not just about having information and mastering the technique, but also, thinking about the current context, it is about understanding knowledge with meaning for social, local and global life, that is, knowing how to contextualize, problematize, relate, compare, interpret the knowledge and information to which we have access. As a result, school education becomes fundamental in the contemporary world, and teachers are essential in this scenario, which requires training consistent with the needs of this new social context, with new attitudes and new ways of thinking about knowledge.

It is worth highlighting that we understand school education according to Rodrigues (1991 apud Gatti et al., 2019, p. 34), as "the minimum indispensable process for all individuals in a given historical society to complete their adequate human formation so that become a social being, or better yet, a cultural entity." Thus, when we understand that human development must be the center of our actions, school education and teacher training take on another meaning, as we come to understand that it is not only techniques that are important in this context, but also human formation. In this way,

> we need to build other perspectives about reality, human beings, phenomena and teaching and learning processes, since the 21st century brings new challenges to be faced" (Suanno, 2015c, p. 67).

However, we cannot forget that for a long time knowledge was seen as an unquestionable truth, based on a closed rationality of the Cartesian paradigm, influencing all contexts of society.

For Morin (2015a), the Cartesian paradigm was based on closed rationality, transforming itself into a true mutilating and one-dimensional paradigm, constituting a thought that isolates and separates, which reduces the whole to its parts. With this, "the modern Cartesian paradigm brought the false illusion that we would be capable of becoming 'owners of the truth', knowing all knowledge" (Cherobini, & Martinazzo, 2005, p. 176).

This way of seeing the world does not match our historical and social needs since the institutionalization of education, which moves us to rethink the parameters of this paradigm, so that we can reformulate our thinking and the way we see reality.

For Morin (2003), this profound blindness regarding the nature of knowledge is due, to a large extent, to the reigning dogma of specialization and abstraction, which disregards the contextualization of knowledge, since contextualization is a fundamental condition for understanding reality.

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Fragmented knowledge no longer meets our current needs. We need knowledge that allows us to know how to contextualize, globalize, multidimensionalize, multireference, that is, think in a complex way. This way of thinking in a contextualized way allows us to look for alternative ways to change the paths to be taken. "The fragmentation and compartmentalization of knowledge in non-communicating disciplines renders the ability to perceive and conceive fundamental and global problems ineffective" (Morin, 2013, p. 183). Fragmentation leads us to the blindness of knowledge, divided and loose, leading to the construction of a one-dimensional view of all things.

Suanno (2015b, p. 6) draws our attention in order to highlight that "thought does not exist independently of someone who thinks, in such a way, learning to think complex demands reforming thinking, demands questioning truths, knowledge, beliefs, traditions and values". But what is complex thinking? What is complexity? How can we think complex? Where to start this thought reform? Is it possible for the complexity paradigm to provide epistemological support in the training of basic education teachers?

These are some questions that we intend to reflect on in this text, seeking to break through and understand the gaps, uncertainties and problems that allow us to have an indefinite or infinite adventure to knowledge (Morin, 2015b) and based on complex thinking, as a central proposal to announce other ways of thinking. Thus, "we need critical heritage, like fish need unpolluted water" (Freire, 1992, p. 5), but, for this to happen, we need complex thinking that expands our levels of perception of reality and reconnects knowledge.

Concept/epistemology of complex thinking:

In the search for a definition of the concept of complex thinking, we initially resorted to the idea of Demo (2017, p. 13), who says that "every definition is just an approximation", since, when we try to define something, we can place limits, in addition to impoverishing or distorting the phenomenon from a point of view, which may be more mischaracterized than revealed. Carvalho (2020) corroborates this by highlighting that when we seek to understand a concept, we must actually fly over that never lands on the object, so as not to mischaracterize it.

In this sense, we seek an approach, an overview of Edgar Morin's ideas, in the search for understanding the meaning of complex thinking. Furthermore, we share the ideas of Suanno (2015a), who states that he is not yet capable of complex thinking, but seeks to make connections and relationships between the parts and the whole, in an attempt to expand and reconnect knowledge and ontological, epistemological and

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methodological references. It is worth highlighting that the word reconnection properly defines the intention of overcoming Cartesian dichotomies (Carvalho, 2008).

Based on this premise, according to Morin (2018b), the initial idea of what is complex is still recognized and generally associated with complicated, confusing. According to Petraglia (2011), the term complexity emerged in the late 1960s, arising from cybernetics, systems theory and the concept of self-organization, revealing a diverse and multiple complex unit.

For Morin (2018b), complexity is made up of several threads, complication, disorder, contradiction, logical difficulty, organizational problems, among others, which when joined together form the fabric of complexity. Thus, "complexus is what is together; it is the fabric formed by different threads that become one thing" (Morin, 2018a, p. 188, emphasis added). The various threads intertwine, forming a complex whole, but this complex unity that was formed from the union of several parts, several threads, does not cancel out the particularities, the diversity of the parts that formed the whole. Machado, Nascimento and Leite (2014, p. 213) corroborate this by highlighting that "complexity must be understood as an articulating principle of thought and action, and not as something difficult and complicated to understand".

In this sense, the center of complex thinking is to distinguish, but not separate (Petraglia, 2011), based on a dialogical and reflective relationship, which is the richest capacity of thinking. Morin (2010, p. 33) defines complex thinking as being "thought that strives to unite, not in confusion, but by operating differentiations", and compares complex thinking to the art of tapestry. To create a piece of tapestry, it is necessary to search for different threads, of different colors, all with their own unique characteristics, which are braided together, take different shapes and create unique pieces. This creation reveals a paradox of the one and the multiple.

Complexity reveals the unfinished, the inconclusiveness of being (Freire, 1996), and that is part of the process of human experience, since complexity is a constitutive factor of the real, constitutive of life, since complexity is everywhere, in all science (Nicolescu, 1999).

Furthermore, complexity reveals to us the dialogical relationship between the subject and the phenomenon, as both are intertwined and co-determined, in addition to indicating that we are co-authors and co-producers of knowledge, since complexity "teaches us that, simultaneously, we are physical beings, biological, social, cultural, psychic and spiritual. All these dimensions involved in our corporeality influence each other" (Moraes, & Suanno, 2014, p. 14), thus seeking to reconnect knowledge.

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In this sense, we can say that:

> we have an epistemology of complexity, which is characterized by being a relationship between theory, practice and the subject's subjective experience, with the aim of favoring the expansion of the subject's levels of perception and consciousness and, thus, favoring the social transformation through the construction of other possible paths" (Suanno, 2015b, p. 99).

In the search for possible ways to be able to think complexly, according to Santos (2008), complex thinking, systematized by Edgar Morin, and transdisciplinarity, systematized by Basarab Nicolescu, articulate and become principles of each other, since both suggest overcoming the dichotomous way of thinking. The epistemology of complexity is one of the constitutive elements of the matrix that generates transdisciplinarity (Nicolescu, 1999; Moraes, & Suanno, 2014).

Transdisciplinarity is complementary to the disciplinary approach; it makes new data emerge from the confrontation of the disciplines that articulate them together; it offers us a new vision of Nature and Reality. Transdisciplinarity does not seek the mastery of several disciplines, but the opening of all disciplines to what unites and surpasses them (Carta da Transdiciplinaridade, Convento de Arrábida – Portugal, 1994).

In this way, transdisciplinarity seeks dialogue with the disciplines, through them, beyond them, but without thinking about their exclusion since what is sought is the expansion of levels of reality, based on rigor, openness and tolerance, these being the fundamental characteristics of transdisciplinarity, as highlighted in article 15 of the Charter of Transdisciplinarity (Freitas, Morin, & Nicolescu, 1994):

> Rigor in argumentation that takes into account all data is the best barrier in relation to possible deviations. Openness involves accepting the unknown, the unexpected and the unpredictable. Tolerance is the recognition of the right to ideas and truths contrary to ours (Carta da Transdiciplinaridade, Convento de Arrábida – Portugal, Art. 15, 1994).

It is worth highlighting that transdisciplinarity is presented by Nicolescu (1999) as consisting of three pillars: level of reality/level of perception, logic of the included third party and complexity. For Nicolescu (1999), reality is everything that resists our experiences, representations, descriptions, images or mathematical formalizations, and the levels of reality are the type of perception on the part of the observer. Moraes and Batalloso (2015) state that:

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> Transdisciplinarity is, therefore, the result of the structural complexity constitutive of reality that unites the different phenomenological levels, the different disciplines, revealing to us that every identity of a complex system is always in the process of becoming, as something unfinished, always open, evolving, changing, transformation process (Moraes, & Batalloso, 2015, p. 75).

According to Carvalho (2008), if we want a change in school education, we must first, and as quickly as possible, require the education of educators. But how to do this? Still according to the author, "fostering the identity between sciences and arts, sciences and traditions, reason and sensibilities, arts and spiritualities, scientific culture and the culture of the humanities" (Carvalho, 2008, p. 19) which were being distanced, fragmented. With this, the author highlights that a school education, with transdisciplinary knowledge, is a good way to stimulate new connections between teachers and students, basic schools and colleges, universities, research centers.

However, it is still necessary to understand that transdisciplinarity "is not a method, but a strategy, an erratic path that crosses knowledge. This is not a prescription for procedures to be implemented in the face of inert objects. The word scares, because it affects consolidated certainties and niches of power" (Carvalho, 2008, pp. 19-20). Transdisciplinarity, like complexity, aims at the constant transformation of ideas, the continuous reorganization of knowledge, outside of closed and decontextualized ideas, since it is what transcends, is between, through, beyond disciplines (Nicolescu, 1999). In this way, what we seek is a constant dialogue, reconnecting, gathering and contextualizing knowledge.

According to Moraes (2014, p. 21), "we live in an uncertain, changing, complex and indeterminate world, subject to the unforeseen and the unexpected". An example of this is the moment experienced with the Covid-19 Pandemic, which placed the entire world, a globalized world, in changes never imagined, modifying the dynamics of society that demonstrated total stability and was characterized as apparently immutable. From one moment to the next we had to relearn how to relate to people and the environment. Science had to form partnerships, surrender to the unknown and seek ways to rediscover what seemed likely. Politics and the economy presented their fragile, unstable and fragmented side. Education revealed what remained hidden. In summary, Covid-19 brought an opportunity to rethink knowledge and information, in addition to presenting our total unpreparedness:

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> faced with the complex and unforeseen situations that happen to us in everyday life, from the simplest and most common traffic accident in a large city like São Paulo or Rio de Janeiro, to those extremely more complex situations related to climate change, floods, fires, the melting of polar ice caps and the droughts that threaten life on the planet. What is observed is the great difficulty we have, both as an individual and as a species, in finding solutions compatible with the magnitude of our current problems (Moraes, 2014, p. 22).

Thus, we continue to face situations that reveal to us that our problems, our daily practices are not disconnected from educational problems, whether at the level of Basic Education or at the level of Higher Education. However, in our daily lives, we develop different practical activities, which we do and which do not require much reflection from us. For Vasquez (1968 apud Pimenta, 2012), this is a habitual practice, it is limited knowledge, and it often becomes automatic. Unlike praxis, which is an intentional activity, as it contains an anticipatory effect of ideas. Thus, praxis has a characteristic of human activity, which is the perspective of the unity of theory and practice, being more than habitual practice. This is how we can think about teacher training, whether in Basic Education or at the level of Higher Education,

> as an opportunity for transformation in the way of thinking, acting and feeling and enabling the space for teaching, research, extension and transformation of people and institutions through eco-training (Suanno, et al., 2015, p. 189).

Given this, Vasquez (1968 apud Pimenta, 2012, p. 100) emphasizes that "all praxis is activity, but not all activity is praxis". In this sense, Freire (1996, p. 22) highlights that "the critical relationship about practice becomes a requirement of the theory/practice relationship without which theory can become blahblahblah and practice, activism". An inseparable intentionality is necessary, reflecting a unity of theory and practice.

We often hear the association of the term praxis, action-reflection-action. But what action are we talking about? A move action? A transformative action? An action related to the practice of doing? According to Morin (2016), action does not just mean movement with application or effect. Action means interactions, reactions, transactions in exchange action, feedback. Furthermore, "action is a decision, a choice, but also a challenge" (Morin, 2015b, p. 79). These actions generate the fundamental organizations that, in turn, generate our universe.

Based on this premise, for Morin (2016, p. 197), "praxis concerns actions that have been It has an organizational character" and differs from a spontaneous action.

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Therefore, this organizational character is related to the idea of organization as a link between components or individuals that produce a complex unit.

Therefore, organization is part of the Trinitarian macro-concept (interrelations – organization – system) of any phenomenon, of any reality and individual, creating a movement that reconnects, transforms, produces, within a movement of circular reciprocity. Thus, Suanno (2014, p. 173) states that "understanding the world as a system is to perceive oneself as integrated into it and, simultaneously, co-responsible for its organization". In this sense, Suanno (2015b) defined praxis as:

> complex and transdisciplinary praxis, that is, the construction of a relationship between theory and practice, based on the Epistemology of Complexity, characterized by being a relationship between theory, practice and the subjective experience of the subject, with the aim of favoring the expansion of levels of perception and of consciousness of the subjects (Suanno, 2015b, p. 73).

Suanno (2015b) also highlights that complex and transdisciplinary praxis is built from the reform of thought characterized by Morin (2011), as the need to reintroduce the knowing subject into this movement emerges, thus requiring teaching that is compatible with this new mode to consider. Given this, Suanno (2015b) states:

> The emerging complex and transdisciplinary didactics is characterized by creating praxis by reintroducing the knowing subject into the production of knowledge and the transformation of the collective lifestyle, self-eco-organizing through the expansion of consciousness, complex thinking (multidimensional, multi-referential, self-referential), transdisciplinary, which reconnects humanities culture and scientific culture, coexists with cognitive uncertainty and historical uncertainty, works didactically based on the emerging paradigm with projects around meta-themes, with the aim that students construct meta-points of view, meta-concepts and actions that contribute to the learning and transformation of people, environments, the way collective life is organized (Suanno, 2015b, p. 3).

It is worth highlighting that the proposal by Suanno (2013, 2015b) for a complex and transdisciplinary praxis, based on complex thinking, seeks to highlight the subject's action in the practical theory unit, bringing the feeling of belonging to this relationship. In this way, it breaks a distance, a fragmentation, the automatic meaning of things, removing us from what Morin (2015b) calls trivial machines, an expression related to our behavior that often keeps repeating, imitating, starting over without much meaning and reflection, since we do not feel like we are part of this movement.

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For Moraes (2007), transdisciplinarity and complexity bring the subject into the teacher training process, as it expands the subject/object relationship. In this sense, Pineau and Patrick (2005 apud, Moraes, 2007) highlight the concept of tripolar formation, being: self-formation, heteroformation and eco-formation. Still according to the authors mentioned, in this tripolar formation, none of the poles should be prioritized to the detriment of the other, given their complex nature. Given this, Moraes (2007) states that:

> teacher training, based on transdisciplinarity, finds in these three complementary axes – self-training, hetero-training and eco-training – its constitutive unit, its main nucleus, the representation of its totality. It is from the operational dynamics between these elements that the constitutive complexity of teaching training action arises. Complexity that appears in the entire training process by integrating and involving training in the relationship with oneself (self-training), training in the relationship with others (heteroformation) and training with the environment (eco-training). This complexity is revealed both at the level of the multidimensional subject, as well as at the technical-pedagogical or sociocultural level, levels that represent the constitutive totality of a teacher training system (Moraes, 2007, p. 26).

Despite the circular and complex nature that exists within the tripolar training process (self/hetero/ecoformation), Moraes (2016) highlights that the self-training dimension needs greater attention, as it is more forgotten in relation to the others. However, the self-education dimension involves a dimension of human consciousness, as "self-education implies taking the reins of life into one's own hands, whether professional or personal, as well as achieving one's existential autonomy, becoming a subject" (Moraes, 2007, p. 25). But, according to the Cartesian paradigm, it tends to neutralize the subject of reality, distancing and fragmenting his gaze. With this, Moraes (2016) also highlights that:

> being, knowing and doing are absolutely united and interconnected in a Gordian knot that is impossible to untie. The conscience the development of such links is fundamental so that we can move towards a new proposal for teacher training based on complexity and transdisciplinarity. A proposal aimed at the education of human wholeness and which recognizes the impossibility of denying the teaching soul, as well as the experiences and stories of personal and professional life that emerge in training processes and contexts (Moraes, 2016, pp. 8-9).

Thus, being (knowing subject), knowing (theory) and doing (practice) constitute the unity of complex transdisciplinary praxis (Suanno, 2015b, 2015c), so necessary for us to reconnect compartmentalized knowledge and rethink a reform of thought based on the

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complex thinking proposed by Morin (2015a). The reintroduction of the knowing subject is part of the cognitive operators of complex thinking (Morin, 2015a).

For Morin (2015a), cognitive operators are complementary and interdependent principles that direct thinking that unites, connects and faces uncertainties, thus being the basis for complex thinking, which is extremely elaborate. Suanno (2015a) corroborates by highlighting that:

> the cognitive operators of complex thinking are the basis for complex and transdisciplinary thinking, as they help us expand our thinking, in a multidimensional view given its complex constitution (whole and parts); multidimensional, social, cultural, but also biological, cognitive subject; multi-referential (Suanno, 2015a, p. 3).

But how to put complex thinking into practice? Is there any possibility? For Moraes and Batalloso (2015), cognitive operators help us to think and understand complexity and put it into practice, reconnecting knowledge from both traditional and complex thinking, in addition to reconnecting knowledge from human experiences to technical knowledge scientific, working in different learning environments, facilitating the perception of complexity in the different dimensions of educational processes.

Thus, cognitive operators help us to think well (Morin, 2018b), as they allow us to establish a dialogue between linear and systemic thinking, simple and complex, reconnecting the knowledge arising from these two ways of thinking. Moraes (2016) states, in search of answers to this question, that there is no single route to be traced, but multiple possible paths to be opened.

Therefore, according to Mariotti (2007), cognitive operators are also instruments of self-knowledge, considering that they enable us to think, reflect, consider the multiple aspects of the same reality, allowing the search and reconnection between facts, between objects that seem to have no connection with each other. It is an articulation of knowledge, and helps us get out of the linear, fragmented thinking, which we usually consider as immutable truth.

In this sense, Mariotti (2007) highlights some of the characteristics of working to "think well", that is, of the practice of complex thinking according to Edgar Morin, such as: it reconnects separate and dispersed knowledge; undoes the closure of knowledge in isolated disciplines; includes a method for dealing with complexity; seeks circularity between analysis (disjunction) and synthesis (reconnection); admits and seeks to deal with uncertainty, randomness, unpredictability and contradictions; conceives and accepts

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dialogic, which includes and goes beyond classical logic; It comprises autonomy, individuality, the idea of a subject and human consciousness, among others.

For Moraes and Valente (2008, p. 35), "the cognitive operators of complex thinking are instruments or categories of thinking that help us think and understand complexity and put this thinking into practice", since these principles- guide helps us think well, contextualizing. According to the authors, Edgar Morin initially established seven cognitive operators, namely: Systemic-organizational principle; Hologrammatic principle; Retroactive principle; Recursive principle; Principle of autonomy/dependence; Dialogical principle and Principle of reintroduction of the knowing subject. Later, Morin and his collaborators added other principles to better understand the educational reality and, mainly, educational research, in the search for good thinking. The new cognitive operators were: Ecological principle of action (Morin, 1999); Principle of Enaction (Varela, & Colls, 1997); and the ethical principle.

It is worth mentioning that we chose, for the research that was carried out in the construction of the dissertation, only four cognitive operators, which will be presented in this article. They are: Systemic-organizational principle; Recursive principle; Dialogical principle and Principle of reintroduction of the knowing subject (Morin, 2010, 2015a, 2018b). This choice came, firstly, because they are central elements in the constitution of complex thought, thus having an identification of these operators with the problem question and with the objectives that guided the research.

According to Morin (2018b), cognitive operators are complementary and interdependent, and they should not be imagined as isolated from each other. Nor should one think that one of them is more or less effective, as they are all interconnected and act in an amalgamated way, although in certain circumstances it is preferable to use one or the other. However, bringing the idea that the center of complex thinking is to distinguish, but not separate, we will present, for a better didactic explanation, the cognitive operators separately.

Systemic-organizational principle

To talk about the systemic-organizational principle, it is necessary to initially talk about the terms system and organization which, according to Morin (2016), are part of the trinitarian macro-concept (system-interrelations-organization) that constitutes the three faces of the same phenomenon, of a complex unit, thus being inseparable. In this sense, the

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> organization of a system and the system itself are made up of interrelations. The notion of system itself completes the notion of organization as much as the notion of organization completes that of system (Morin, 2016, p. 180).

Therefore, the system is a complex unit that arises from the diversity of interactions and organization of elements, actions, individuals. A system is anything, and what is extraordinary about a system is that it has its qualities that are called emergent, as they only emerge when the system is constituted (Petraglia, 2011).

According to Morin (2016), the idea of system emerged in the sciences that deal with systemic phenomena, such as chemistry, physics, astrophysics and thermodynamics. However, the idea of a social system still remains trivial. Carvalho (2019) corroborates by highlighting that the fact that the idea of a social system still remains trivial and rejected, in most cases, can be related to great resistance, mainly by the human and social sciences, due to the lack of understanding, in explaining the idea of system, in addition to messing with the hegemony of knowledge that is based on dominant modern thought, whose principles are disjunction, reduction, abstraction and simplification.

This systemic organization of the social system, according to Carvalho (2008), can be understood through the relationship between nature and culture, which does not constitute exclusive dualities, but are simultaneously opposite and complementary dualities. In this sense,

> we constitute ourselves as "natural" beings because they are inscribed in a complex biological order; cultural because they are capable of producing, accumulating and communicating survival and adaptation strategies, in the short, medium and long term, wherever we are (Carvalho, 2008, p. 18).

Thus, we can understand the idea of a system that connects all things based on an open and closed relationship, order and disorder, that is, a dialogical and circular relationship. In this sense, we use the example presented by Moraes and Valente (2008) to understand this principle:

> If the relationships between the researcher and the researched object are constraining, coercive and inhibiting behavior or actions, the result may certainly be very different and express something with lower informational quality than when the interactions that are established are based on trust, partnership and of collaboration. When the climate generated in the partnership is trustworthy, cooperative, relaxed, it is very likely that the research result will express the good quality of these relationships, since the conduct of one ends up influencing the conduct of the other, as well as their entire procedural dynamics (Moraes, & Valente, 2008, pp. 36-37).

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This dynamic can also be observed in initial teacher training, which, according to Garcia and Alves (2004), the process of fragmenting knowledge into disciplines, with specialization being the current need for the 21st century, imposed divisions in schools and teacher training. These divisions can be perceived when students are invited to seek the foundations of education to better understand the reality observed in schools.

However, according to the authors mentioned, students do not know how to make connections because they only see disconnected fragments that do not make sense. Thus, students experience a process of learning to memorize and repeat what renowned authors said, without learning from them how to create, discover and think.

Still according to Garcia and Alves (2004), this happens mainly through the selection of content, which is chosen based on the criteria of someone who considers themselves in a position to make a choice. This choice privileges some aspects, since much knowledge, called pedagogical content, is not available at school, such as, for example, useless knowledge, knowledge related to everyday life. In this sense, this selection fragments knowledge, as it is removed from its contexts and is not considered in the process of human formation.

Sometimes they also highlight the naturalization of specialization and control of bodies through submission.

When we decontextualize, our vision becomes fragmented, causing the parts to not function as parts and the whole to not function as the whole, generating a split in the complex system, since, to emerge, the system needs its environment and the observer. Santos (2008) highlights that:

> Contextualization is necessary to explain and give meaning to isolated phenomena. The parts can only be understood based on their interrelations with the dynamics of the whole, highlighting the multiplicity of interacting elements which, to the extent of their integration, reveals the existence of different levels of reality, opening up the possibility of new visions about the same reality (Santos, 2008, p. 74).

In this sense, the idea of a system breaks with the idea of a closed object, as any object is a system. Thus, "the whole only functions as a whole when the parts function as parts" (Morin, 2016, p. 159), since both contribute to the organizational system of any object. Furthermore, according to Morin (2016), we know objects based on our perceptions and representations. However, classical science constituted this object isolated from us, thus isolating the object from the observer, as if the object were closed

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and distinct, independent of its environment. "Thus, the objectivity of the universe of objects is maintained through double independence in relation to the human observer and the environment" (Morin, 2016, p. 124). Therefore, the human observer and the environment cannot remain outside, oblivious to any system, as the whole is in the parts, just as the parts are in the whole.

Recursive principle

The recursive principle, also known as the recursive circuit principle or circularity, is defined by Morin (2018, p. 95) as "a generating circuit in which products and effects are themselves producers and causes of what they produce". In other words, the idea of circuit refers to the idea of circulation, self-producing of its organization, in a constant spiral movement. This principle helps us understand, for example, the "fact that the individual produces society and is at the same time produced by it" (Moraes, & Valente, 2008, p. 40). Unlike linear-binary thinking, which understands the cause-effect relationship, the recursive principle boils down to two moments: beginning and end, or absolute determinism. In this sense, Morin (2016) states:

> I define as recursive any process through which an active organization produces the elements and effects that are necessary for its own generation or existence, a circuitry process through which a product or effect becomes an initial element or cause. It can then be seen that the notion of circuit is much more than retroactive: it is recursive (Morin, 2016, p. 229, emphasis added).

According to Suanno (2013), even though they are complementary, there is a basic difference between the retroactive principle and the recursive principle. While the retroactive principle explains the notion of self-regulation and circular dynamics, the recursive principle brings the notion of self-organization and spiraling circular dynamics. In other words, the recursive principle brings the idea that the end of the process feeds the beginning, in a constant interaction that does not make it possible to demarcate beginning and end, but to understand the existing circular movement. As Morin (2018a) states:

> We, individuals, are the producers of a reproduction system that comes from the beginning of time, but this system cannot reproduce if we ourselves do not become producers through mating. Human individuals produce society in and through interactions, but society, as it emerges, produces the humanity of these individuals, providing them with language and culture (Morin, 2018a, p. 95).

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Thus, the retroactive and recursive principles present reality in a multidimensional way, since reality always has an individual dimension, a social dimension and a biological dimension, in addition, it is multi-referential based on the circularity of complex systems, since

> depending on the processes in synergy, this circular causality can produce new emergencies, based on self-eco-organizing processes, regenerators of the system itself or creators of new emerging systems (Moraes, & Valente, 2008, p. 40).

Dialogical principle

According to Gadotti (1990), the word dialectic comes from ancient Greece and expressed a specific way of arguing. Socrates was considered the greatest dialectician in Greece, being an instigator and the disciple the discoverer and creator. Gadotti (1990) also highlights that Hegel conceives the rational process as a dialectical process in which contradiction is not considered illogical, considering that thought is no longer static, but proceeds through overcome contradictions, from thesis (statement) to antithesis (negation) and then to synthesis (conciliation).

A proposition (thesis) does not exist and without opposition to another proposition (antithesis). The first proposition will be modified in this opposition process and a new one will emerge. Thus, the conciliation existing in the synthesis is provisional insofar as it itself becomes a new thesis. In this sense, for the Hegelian conception, contradictions always find a solution, in a constant interactive movement.

According to Mariotti (2007), unlike dialectics, the word dialogic means that there are contradictions that cannot be resolved. In them, the tension of antagonism is persistent. For Morin (2018b), this dialogical principle brings the idea of uniting opposites to conceive a complex phenomenon. In other words, the dialogic principle can be defined as the complex/complementary/competing/antagonistic association of opposites, thus overcoming the idea of dichotomy such as order/disorder, part/whole, simple/complex and bringing a relationship of dialogue between opposites. Complexity, through the dialogic principle, seeks to articulate terms such as:

> order/disorder, positive/negative, universal/singular, body/soul, subject/object, feeling/reason, without excluding one for the other, recognizing duality within unity and the union of apparently antagonistic terms, but for reason complex are also complementary (Cherobini, & Martinazzo, 2005, p. 171).

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Thus, this dialogical movement presents the idea of something that is always in process, of something unfinished, taking us to a future. For Morin (2018a, p 180), "dialogic means that two logics, two principles, are united without duality being lost in this unity". Suanno (2013) states that the coexistence of opposites gives us a vision of the complementarity and inseparability of apparently antagonistic notions, events, phenomena, aspects that happen at all times, without the intention of eliminating the contradictory or seeking a consensus, but of respect your differences.

However, it is worth highlighting that the dialogical principle does not intend to replace dialectics, since "its objective is to deal with contradictions that cannot be overcome dialectically" (Mariotti, 2007, p. 10). We understand that some circumstances exist and are not possible to be resolved. The dialogical operator seeks to work with opposing and irreconcilable positions, recognizing them, but without trying to deny or rationalize them.

In this sense, Moraes and Valente (2008) highlight that this dialogical principle can be observed in the relationships between researcher and the researched object, which establishes different dialogues between subject/object, individual/context, local/global, theory/practice, among other dialogues, placing the researcher as part of the whole that he intends to explain. Therefore, according to Suanno (2013):

> The concept of dialogicity commits the individual to be aware of the need to understand the relationships between the subject and the object, between the individual and their context, as well as perceiving themselves in the relationship established for the investigation they intend to undertake, remembering the impossibility of separation of the investigating subject from the investigated object. Since the whole is made up of parts and each part brings within itself the formative aspects studied (systemic-organizational principle), it indicates that everything is related to everything, at its different levels (hologrammatic principle), and that acts committed in a investigation return to the issuing subject in an action of self-organization (retroactive principle) in which every action, physical or mental, was a product and producer of what produces it (recursive principle) (Suanno, 2013, p. 62).

This is a constant exercise and demands greater contextualization, a sensitive look and listening, an expansion of the levels of perception of reality, since conflicts and contradictions are part of the individual, society, the relationships of any complex system, as they are these interactions that bring to light the diversity of the universe, constituting the operative form of complex thinking (Morin, 2018b). Given this, Mariotti (2007) states that:

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> Dialogic seeks to deal with variables and uncertainties that cannot be eliminated. When we teach how to live with paradoxes, the dialogical operator also shows us how to identify the possibilities and limitations of objectivity, linear logic and quantification. Our claim to control everything, including what is not controllable, is an attempt to reduce anxiety and insecurity. However, by wanting to control the uncontrollable we only manage to temporarily deny it. It's like holding down a spring. The more energy we spend keeping it tense, the more tired we become and the more difficult it becomes to press. Knowing how to distinguish when to use dialectics and when to use dialogics is a skill of high strategic value (Mariotti, 2007, p. 12).

Therefore, the big question is to combine the simple and the complex without eliminating one or the other, but recognizing the existence of opposites and their complementarity. Thus, the individual takes his place in the dialogical relationship.

Principle of reintroduction of the knowing subject

For Morin (2015a, p. 65), "being a subject means placing yourself at the center of your own world, occupying the place of me", since no one can occupy this place that is individual to each person. However, according to Suanno (2015b), starting from Descartes, a science without a subject was constituted, and this place was being denied, replaced by a distancing, fragmentation and objectivity of reality, as object and subject were distanced.

The principle of reintroduction of the knowing subject rescues the subject capable of knowing, transforming, creating, and who has been forgotten for a long time, left out of knowledge, denying the idea that "all knowledge is a reconstruction/translation by a mind /brain in a culture and at a specific time" (Morin, 2018b, p. 96). In this sense, Carvalho (2008) states that:

> Intellectuals usually separate the life of the knowing subject, generally hidden, from the ideas he professes. They forget that everything we say is produced by a personal story, sometimes full of suffering, pain, setbacks and a few joys. The restoration of the responsible subject in education requires the explanation of the life-ideas dialogue. Of course, coexistence between the two is never completely peaceful. It is, however, from the clash between them that a new subject of knowledge may emerge (Carvalho, 2008, pp. 21-22).

Thus, the reintroduction of the knowing subject places the observer to be part of what he observes, since the human being is part of a social system (Morin, 2016), thus being a complex being. With this, the observer is not separate from what he observes; We cannot live in the world as if we were not part of it. "Because we are all in the same world, we are at the same time subjects and objects, perceivers and perceived. If consciousness

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is always the consciousness of something, things are always things for some consciousness" (Mariotti, 2007, p. 17). In this sense, Suanno (2013) states that:

> Reality is perceived by the subject who observes it, and from this perception, this subject shows his way of seeing, recognizing, interpreting, constructing, deconstructing and reconstructing his knowledge, showing the reality that depends on the subject who interprets it. This knowing subject thus demonstrates the functioning of its internal and external causal factors, influencing them mutually (Suanno, 2013, p. 65).

Thus, our perception of reality is influenced by who we are individually and by the relationships we establish, since it is through relationships that perceptions emerge. Mariotti (2007) states that:

> Perception is a dialogue, a transaction between the observer and the observed, between the perceiver and the perceived. One cannot know the real world through objectivity alone. It is also not possible to know it through subjectivity alone. To know reality, it is necessary to establish a relationship with it, interact, exchange, live together (Mariotti, 2007, p. 18).

In the process of initial teacher training, this relationship of exchange and interaction plays a primary role, since in this relationship between teacher and student there is the opportunity to establish paths and possibilities based on a relationship of trust, respect and cooperation, taking into account each person's life stories, emotions, motivations and desires, establishing a bond of sharing and reconnecting knowledge, in addition to expanding the perception of reality, in a multidimensional and multi-referential way.

With this, we agree with Morin (2018a), who indicates that when we seek a thought that unites and solidifies previously separate, distant and fragmented knowledge, we are capable of unfolding ourselves into an ethics of union and solidarity between humans, since when we feel like we belong to something, we understand the meanings and meanings of things, bringing the wholeness of our being. In this sense, we can say that complexity proposes a new way of articulating knowledge, without excluding, but uniting knowledge that was once distanced and fragmented.

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RESUMO:
Exercer a docência e ser professor, não se trata apenas de ter informação e dominar a técnica, mas também, pensando no contexto atual, compreender o conhecimento com significado para a vida social, local e global, ou seja, saber contextualizar os conhecimentos e informações ao qual temos acesso. Com isso, a educação escolar se torna fundamental no mundo contemporâneo, e os professores são essenciais nesse cenário, o que exige uma formação condizente com as necessidades desse novo contexto social, com novas posturas e novas formas de pensar o conhecimento. Faz-se necessário um paradigma que mostre a necessidade de um pensamento que une e solidariza os conhecimentos, que traz a inteireza do ser, surge então o pensamento complexo esse meio.

PALAVRAS-CHAVE: Pensamento Complexo; Transdisciplinaridade; Operadores Cognitivos.

RESUMEN:
Enseñar y ser docente no se trata sólo de tener información y dominar la técnica, sino también de pensar en el contexto actual, comprender conocimientos con significado para la vida social, local y global, es decir, saber contextualizar los conocimientos y la información a los que nos enfrentamos. tener acceso. Como resultado, la educación escolar se vuelve fundamental en el mundo contemporáneo, y los docentes son esenciales en este escenario, que requiere una formación acorde con las necesidades de este nuevo contexto social, con nuevas actitudes y nuevas formas de pensar el conocimiento. Se necesita un paradigma que muestre la necesidad de un pensamiento que una y solidifique el conocimiento, que acerque la totalidad del ser, entonces emerge en este entorno el pensamiento complejo.

PALABRAS CLAVE: Pensamiento Complejo; Transdisciplinariedad; Operadores cognitivos.