EMP Educação Matemática Pesquisa
ISSN 1983-3156
Qualis A1
http://dx.doi.org/10.23925/1983-3156.2024v26i2p098-127

Action investigative methodologies for the sciences of the imprecise

Metodologías de investigación acción para las ciencias de lo impreciso

Méthodologies d'investigation-action pour les sciences de l'imprécis

Metodologias investigativas de ação para as ciências do impreciso

Iran Abreu Mendes[1]
Universidade Federal do Pará (UFPA)
Doutorado em Educação
https://orcid.org/0000-0001-7910-1602

Abstract

The construction of sciences started from imprecision, vague regularities and the attempt to standardize variants through explanatory rules for the diversity of natural, social and cultural phenomena. Since the 18th century, epistemological criticisms about the status of the scientific method and its inaccuracies have provoked philosophers and researchers in this regard. Based on a historical study of this theme, in this article we discuss philosophical and methodological principles about uncertainties in the exact, natural and human sciences, enunciated by a group of authors who in the 1964s pointed out reflections on research within the sciences of the imprecise, to react to scientific certainties and a precise image of science created between the 19th and 20th centuries, which strengthened prejudices against the imprecise. The discussion by the group of authors researched pointed out a list of research methods within the scope of the imprecise, such as helping to understand and explain scientific facts, related to certain natural, sociocultural and human phenomena, which cannot be explained by a single cause, or by a single epistemological or methodological model.

Keywords: Science of the imprecise, Research method. Science of uncertainty, Applied methodologies.

Resumen

La construcción de las ciencias partió de la imprecisión, de regularidades vagas y del intento de estandarizar variantes mediante reglas explicativas de la diversidad de los fenómenos naturales, sociales y culturales. Desde el siglo XVIII, las críticas epistemológicas sobre el estatus del método científico y sus imprecisiones han provocado a filósofos e investigadores a este

[1] E-mail: iamendes1@gmail.com

respecto. A partir de un estudio histórico de esta temática, en este artículo discutimos principios filosóficos y metodológicos sobre las incertidumbres en las ciencias exactas, naturales y humanas, enunciados por un grupo de autores que en la década de 1964 señalaron reflexiones sobre la investigación en el seno de las ciencias de lo impreciso. , para reaccionar ante las certezas científicas y una imagen precisa de la ciencia creada entre los siglos XIX y XX, que fortaleció los prejuicios contra lo impreciso. La discusión del grupo de autores investigados señaló una lista de métodos de investigación dentro del ámbito de lo impreciso, como ayudar a comprender y explicar hechos científicos, relacionados con ciertos fenómenos naturales, socioculturales y humanos, que no pueden explicarse por una sola causa. , o por un único modelo epistemológico o metodológico.

Palabras clave: Ciencia de lo impreciso, Método de investigación, Ciencia de la incertidumbre, Metodologías aplicadas.

Résumé

La construction des sciences est partie de l'imprécision, de vagues régularités et de la tentative d'uniformiser les variantes à travers des règles explicatives de la diversité des phénomènes naturels, sociaux et culturels. Depuis le XVIIIe siècle, les critiques épistémologiques sur le statut de la méthode scientifique et ses imprécisions provoquent à cet égard philosophes et chercheurs. À partir d'une étude historique de ce thème, nous discutons dans cet article les principes philosophiques et méthodologiques sur les incertitudes dans les sciences exactes, naturelles et humaines, énoncés par un groupe d'auteurs qui, dans les années 1964, soulignaient des réflexions sur la recherche dans les sciences de l'imprécis. , pour réagir aux certitudes scientifiques et à une image précise de la science créée entre le XIXe et le XXe siècle, qui ont renforcé les préjugés contre l'imprécis. La discussion du groupe d'auteurs étudiés a mis en évidence une liste de méthodes de recherche qui s'inscrivent dans le cadre de l'imprécis, comme aider à comprendre et expliquer des faits scientifiques, liés à certains phénomènes naturels, socioculturels et humains, qui ne peuvent être expliqués par une seule cause. , soit par un modèle épistémologique ou méthodologique unique.

Mots-clés : Science de l'imprécis, Méthode de recherche, Science de l'incertitude. Méthodologies appliquées.

Resumo

A construção das ciências partiu do impreciso, das regularidades vagas e da tentativa de padronização de variantes por meio de regras explicativas da diversidade de fenômenos

naturais, sociais e culturais. Desde o século XVIII as críticas epistemológicas sobre o estatuto do método científico e de suas imprecisões provocaram filósofos e pesquisadores a esse respeito. Com base em um estudo histórico essa temática, neste artigo discutimos princípios filosóficos e metodológicos sobre as incertezas nas ciências exatas, naturais e humanas, enunciados por um grupo de autores que na década de 1964 apontou reflexões sobre a pesquisa no âmbito das ciências do impreciso, para reagir às certezas científicas e uma imagem precisa da ciência postas entre os séculos XIX e XX, que fortaleceu preconceitos contra o impreciso. A discussão do grupo de autores pesquisados apontou um rol de métodos de pesquisas no âmbito do impreciso, como auxiliar na compreensão e explicação de fatos científicos, relacionados a determinados fenômenos naturais, socioculturais e humanos, que não podem ser explicados por uma única causa, ou por um único modelo epistemológico ou metodológico.

Palavras-chave: Ciência do impreciso, Método de pesquisa, Ciência da incerteza, Metodologias aplicadas.

Investigative Action methodologies for the sciences of the imprecise

The origins of this article come from an inaugural class given at the VII School of Advanced Studies on Research in Culture, History, and Education, held from February 24 to 28, 2024 (cf. Farias; Mendes, 2024). The text is characterized as a historical review of the topic as it relates to studies on research methods since most of the aspects that I will address in the sections in this text constitute a discussion announced around 1964, by a group of French researchers, called Methodological Study Group of the Comité National de L'Organisation Française (C.N.O.F.).

The group mentioned above intended to present their epistemological reflections and methodological procedures regarding contemporary sciences announced at the end of the first half of the 20th century. They focused on the processes of social, scientific, and technical or technological transformations arising from the generation of scientific production through research between the end of the 19th century and the Second World War. At that time, we witnessed the emergence of the first few ideas about information science and interdisciplinarity in the production of knowledge by the different branches of science.

Thus, in 1964 the group published the book *Méthodologie vers une science de l'action*[2], organized by Roland Caude and Abraham Moles with texts by several authors including H. Bour, J. P. Cagnard, J. Camion, J. Chouleur, J. . Dubas, R. Feron, M. Girault, R. Larger, J. Lobstein, J. Y. Martin, H. Migeon, H. Roy, R. P. Russo, and the organizers themselves. Of all the authors mentioned above, one of them can be considered a main representative of this group - Abraham Antoine Moles, a French electrical engineer and acoustic engineer, who in addition to having a doctorate in physics and philosophy, was also a professor of sociology, psychology, communication and design at the "Hochschule für Gestaltung d'Ulm"[3] and at the universities of Strasbourg, San Diego, Mexico and Compiègne[4].

Abraham Moles has published more than 20 books, authored or co-authored with other researchers of his generation, focusing on topics related to communication, computing, philosophy, physics, language, phonetics (speech), experimental music, urban anthropology, culture, epistemology[5], creativity, and innovation, among other themes that characterized his

[2] Méthodologie vers une science de l'action.
[3] Higher school in Ulm, Germany; A School of Design founded in 1953 by Max Bill and others to promote the principles of Bauhaus art.
[4] The University of Technology of Compiègne is a public research university in Compiègne, France. It holds the status of a public university and a great École. It was founded in 1972 as France's first Experimental Institute of Technology.
[5] In this essay we will adopt epistemology as the philosophical doctrine of the foundations and methods of scientific knowledge, whose object of study is the production and validation of scientific knowledge, that is, it analyzes the

transdisciplinary vocation as a researcher and thinker. It was from his vast body of work that I selected the book entitled *Les Sciences de l'imprecis*, originally published in 1990, translated into Brazilian Portuguese in 1995, in which the author presents us with a scientific-philosophical essay text in which he exposes his understanding that there are no definitive certainties even in areas such as the so-called exact sciences, let alone in the human sciences.

However, more than three decades after the first edition of the publication of *Les Sciences de l'imprecis*, the results presented in all branches of contemporary sciences converge to the focal point defended as a thesis supported by Moles' arguments. This article focuses on this theme, associating it with the book published by the French group in 1964 and taking as an object of exposition and discussion the sciences of the imprecise and their investigative action methodologies.

To delve into the topic, in the following sections, I will clarify what are some of the founding concepts of imprecise science, so that it is possible to connect them to the research methodologies that shape this approach to scientific investigation, based on the discussions that originated in the work of the French group in 1964, presented in the book *Méthodologie vers une science de l'action* (Moles; Caude, 1964). To present these concepts, I will begin with four questions announced in the following sections: 1) What is understood as an imprecise science? 2) What are the methodologies of this science of imprecision? 3) What am I considering as investigative action methodologies based on the inflections or emphases given to the topic by the authors that were researched during the elaboration of this article? 4) What principles and methods establish them as investigative action methodologies, since the authors do not emphasize such aspects directly in their principles and methods?

On what is understood as a science of the imprecise

Regarding the sciences of the imprecise, for Moles (1990; 1995) its central principle is that the imprecise must be adopted as knowledge or as the scientific destiny of the West, organizing itself into categories of imprecision. For the author, imprecision is not simply the opposite of precision, an idea that was historically instilled in us as a founding principle of Rational Science, established over the centuries that preceded contemporary sciences, which were characterized mathematically, for example, by differential calculus, especially limit theory, quantum physics, and *fuzzy* logic, not to mention the theory of irrational numbers since its beginnings, with the discovery of the Pythagoreans, given that:

criteria by which knowledge is justified, in addition to considering the historical, psychological and sociological circumstances that lead to its achievement.

> In our daily life, in our environment, there are objects that no longer belong to the world of nature: they are shapes and colors, they are other men, they are impressions within our field of consciousness, and all of these are repeated or renewed according to the laws which we have ignored for a long time, but of which none of us – including physicists, astronomers, and biologists – can reject the evidence nor the general character (Moles, 1995, p.24).

In this context, Moles (1995) considers aspects related to a few types of vague phenomena to explain how he understands this science, asserting that there are three categories of vagueness. Vague phenomena exist because the probable error in their determination is large or very large and because the phenomenon as a form has vague or variable contours, changing from one occurrence to another. We must certainly try to know the causes of the variability of these contours, but while examining this fact we must name and deal with these phenomena. The author mentions as an example the explanation of the local microclimate of a small town (whether or not it will rain tomorrow) since it is a fact that, depending on where we are, may or may not have a certain importance or even escape our methodological assessment. Similarly, we can cite the example of predicting tides in certain coastal regions or at the mouths of some Brazilian rivers such as the Amazon.

Moles (1995) also clarifies that many phenomena that remain vague to us because we do not have adequate techniques to operationalize and express their measurement. In this case, we must make a conceptual effort to fit them within possible measures. For example, we can propose the following question: what is the magnitude of an action? How do we measure actions and express such measures? This category includes many phenomena we can't experiment with (or can't experiment properly) – even when we can think of an experiment.

Finally, Moles clarifies that there are still essentially vague phenomena, that is, phenomena enunciated by vague, perhaps inadequate concepts, which are the only option. The author argues that it is necessary to study them using what we know, without trying to force the concepts towards a precision that destroys their meaning, developing the relationships that exist between these concepts in a "rigorous" way, that is, is, according to the law of reason. To a fair extent, the phenomena that involve several studies in ethnomathematics or sociocultural practices come close to the phenomenal characterizations attributed by Moles (1990; 1995) in his *science of the imprecise*.

Based on what Moles (1995) describes, we interpret that in any case, the correlations between quantities, when expressed through correlative diagrams, enable the qualitative measurement of the phenomenon in its causes and effects, as long as they, the quantities, are well defined, and can therefore generate weak, medium or strong correlations. In short, the

author highlights that, at the level of poor rationality and minimal scientificity, the relationship between measurement and precision implies the maintenance of the ideology of precision, since it is an epistemology of correlation between the logic and infralogic[6] correlated in the concept of imprecise as a specific discipline of thought regarding the diversity of sociocultural phenomena at their threshold of uncertainty.

On the methodologies of the science of imprecise

Regarding the nature of the science of the imprecise and what are its methodologies, its general characteristics, and applications, as early as the 1960s, Roland Caude (1964), highlighted that the organization of human relations seems to complete the application of the spirit of observation and experimentation to the sciences of the imprecise. Regarding this subject, the author announced that in the last decades of the 19th century and the first decades of the 20th century, there was a turnaround in traditional scientific notions due to the multiple interferences between the problems of science and the technologies operationalized by the advent of information sciences and the external environments in which they were immersed. As a result, socio-scientific problems grew in complexity and, often, in complications.

Caude (1964) states that, according to certain rules, the complex that is made of elements or chains of elements linked together can be analyzed quickly, if one has certain instruments. But juxtaposing a set of elements of different orders, which forced the scientific spirit into a series of successive analyses with no connection between them, is complicated. Thus, it was up to the scientific organization to maintain control of the complex structures and untangle the complicated problem. However, this was no longer possible, neither with the help of classical culture nor through an accumulation of knowledge that the specialized training we received hardly favors.

Therefore, the level and even the nature of the problems changed, as a new approach seemed to be necessary: instead of focusing on the standards of good organization of traditional scientific research, it became necessary to create or discover the best methods of approaching these problems. In other words, it would be less important to find ideal solutions on such and such particular points than to highlight a set of methods connected or not to specific disciplines capable of quickly and effectively solve the largest number of problems in the world.

[6] Infralogic does not mean, in any way, that they are inferior operations, strictly speaking, when compared to logical-arithmetic operations, but simply that they form the notion of an object as such, as opposed to the set of objects, that is, they are invariably related to actions that human beings perform on objects.

The emergence of new methodological approaches to solving research problems characterizes the period we are living in and leaves deep marks in the new trends in our thinking and scientific training. It practically implies the combination of a scientific spirit, philosophical thought, and a concrete experience of men and women, combined with a rare faculty: creativity. Creativity can be defined as a particular capacity of the mind to reorganize and to rewire the brain's supply, in an original way capable of giving rise to real operations, to methods applicable in the most varied activities (research, training, organization, production, information, exchanges, etc.), as highlighted by Moles (1957; 1998) in the book *La creation scientifique* [Scientific creation].

In the search for answers to the second question, we must answer, after all, what are the imprecise methodologies, if they do exist? In the literal sense, methodology is the integrated science of methods, a method being the mind's rational walk to discover truth (or solve a problem). In this regard, in the first decades of the 20th century in the book Introduction to Leonardo da Vinci's method, Paul Valéry (1919; 2006) defined methodology as a system of externalizable operations that does the work of the mind better than the mind. Thus, a methodology would then be explained as the study of the best way we could, in the current state of our knowledge, approach certain problems. It means, therefore, that we do not just look for solutions to problems, but rather we seek to choose more appropriate ways of finding solutions, integrating the knowledge acquired about the current methods in the various scientific or philosophical disciplines.

We could strive asymptotically (in the mathematical sense of the term, used here as an analogy or allegory) to discover the method that would make our thoughts adjust to simple and limited cognitive molds. We write the method and not the methods, but in practice we must review the ways in which these methods are used because we have our scientific discipline to pursue in research on the object or problem to be investigated, in relation to the phenomenon involved in our studies. As we shed light on the plurality of these methods, such a methodical inventory must imply an aspiration to a unity, which perhaps one day will be realized in an abstract mathematical framework that combines generality with precision, as it remains and, without a doubt, will remain for a long time as an ideal for the mind.

Methodology, therefore, naturally comprises, and above all, logic, a set of rules that govern the organization of the functioning of thought and its two extensions to the inner world and the outer world: intuition (imagination) and experimentation. For Moles (1964), logic is the science of thought's agreement with itself, while method is the science of thought's agreement

with the object of its desire. However, I emphasize that validation of the method must be a part of this agreement of thought with itself, after experimentation.

Logic, defined by some as the art of wandering with certainty, and by others as reasoning correctly, represents an effort of the mind to organize knowledge and adapt it to reality. Ancient classical logic was profoundly renewed by modern logic, which attempted to bridge the gap between the rational and the irrational, and also by scientific or logistical logic, which introduced mathematics into reasoning and made it possible to encompass larger sets.

Therefore, this is the dialogical game between intuition and experimentation, guided by the method and the need to express thought through concepts that allow us to order reality.

> The abyss between the already known conceptual systems and the new conceptual systems can be overcome by intuitive thought as if by a leap, but it cannot be overcome by building a bridge of formal conclusion. When we move from a clearly understood and scientifically ordered region of reality to a new region, we find ourselves once again in the situation of the child who needs to simultaneously learn to think and speak, of the child who still cannot speak, since expressible thoughts are foreign to them and they cannot think yet, given that they lack the concepts from which thoughts can be ordered and with which they can be articulated (Heisenberg, 2009, p. 16-17).

It is in the same uncertainty-focused approach proposed by Heisenberg that we understand how Moles (1964) conceives his science of imprecision and its methods, highlighting that there are many other kinds of logic, more flexible, sometimes more creative, that can be grouped under the generic term *infralogics*, in which associations of ideas display coherence, less rigorous evidence. Corporate life, routine habits of thought and the evocation of common sense are part of the most banal infralogical systems, providing intellectual comfort that is detrimental to the renewal of organizational structures or the making of creative decisions.

Intuition is a difficult concept to grasp that allows instinctive, immediate knowledge, without prior reasoning, following a set of unconscious and multifaceted perceptions, which often translates into a strong conviction without formulable reasons and plays a fundamental role in actions and decisions of those responsible for them. For their part, observation and experimentation continue to be essential for the construction of theories to build science onto which new techniques and methods are grafted in the classical sense of the term, in the preparation and organization of work.

In terms of methodology, the first problem that arises for a researcher is to know whether the methods are all at the same level of abstraction and complexity; otherwise, they must prioritize, starting from a method accepted as ideal, going through methods and sub-methods,

until they can reach very elementary processes that should no longer have this name: processes, recipes, tips, tricks, etc. (Moles, 1964).

What underlies this reflection by Moles is that, at a lower level, methods become, on the contrary, procedures, directives to follow, and recipes for applying other broader methods from which they proceed. To simplify the work, for example, the basic method is general analysis combined with a certain number of processes: timing, instantaneous observations, intentional reflection, experimentation, and imagination. Therefore, the method consists of a combination and a set of processes that make up the path of searching for a desired truth, that is, the desire for knowledge. Therefore, the result obtained represents a series of practical guidelines whose end is to introduce the new simplified procedure.

It seems that we should treat the term method as an apparatus to be used by a mind that seeks and not a mind that finds what has already been found. For Moles (1964), what could have been a method at a certain moment in the life of a man or a woman, or of an entire civilization, having fallen into the domain of habit and current practice, is no longer so. A method is related to a category of problems, with each problem accompanied by specific data that distinguish it from any other problem in that category.

The method solves the problem independently of the data since only existence is postulated. The definition needs data each time the method is implemented. But this implementation is not some kind of external light that illuminates the way forward; light emerges from the brain and travels different possible paths; it guides, but it does not impose; leaves the field open to intuition, initiative, and freedom. As a result, this light is never sure of succeeding every time. It simply gives maximum chances of success in a given operation (Moles, 1964).

As I mentioned previously, in the context of action research methodologies, imagination and creativity play an essential role, as they are qualities stimulated by the knowledge of fundamental structures, particularly in the investigation of sociocultural practices related to mathematics (in terms of thought and representation) and their systematic research into various sets or real situations. The method, on the other hand, is organization, a pondered action that implements the structures for this purpose. This science of action or acts is an authentic science that implies creative attitudes, the perception of essential factors in relationships and structures, and the sense of interconnection that involves theory and reality.

These research methodologies related to the sciences of the imprecise can make a notable contribution to investigative action methodologies, especially since these sciences focus on the human sciences. In this sense, in problems located in sociocultural contexts, solutions

often also become inaccessible to the majority of brains impregnated with a "mosaic" culture, as expressed by Moles (1964; 1995; 2012), which is made up of a disorderly flow of excessive and random information.

This, at least, is the impression that the current lack of knowledge of an integrated methodology gives us, for today we see three new factors disturbing humanist culture: the immensity and variety of information and communication technologies (ICT), the increasingly abstract processes for the elaboration of mathematical structures and their implications in sectors related to their applications, and the prodigious advancement in the development of digital applications for systematization, analysis, and representation of research results and communications of the results obtained.

With these new methodologies, we see the emergence of more abstract, but also more fruitful notions, bearing interdisciplinary interest, allowing synthetic, global, faster, more effective approaches, which renew in depth our mental structures of knowledge and understanding, among which I highlight the notion of dimension, which allows an ordering of complexity in the most diverse domains: each concrete or abstract object has a wide variety of dimensions, that is, characteristic attributes.

An object called an automobile, for example, has a certain number of classical dimensions that place it in our space (length, height, wheelbase, etc.), distances covered, etc.); in short, everything that can characterize both its functional aspect and its structural aspect. Any object of our investigative interest will also have a multiplicity of dimensional varieties, that is, of characteristic and specific attributes of these objects, which can be foci of investigation. Therefore, there is no single method that can cover such a multiplicity.

Some problems when applying these methodologies

Language, in all its forms, is an ideal instrument of understanding, but confusion often arises between knowledge of the language of science and the methods and between science or the methods themselves. This confusion occurs due to the different scientific disciplines systematically employing vocabularies that are completely specific to each of them and strange between them. Therefore, there is a need to clarify and simplify these differences so that certain methods do not lose their effectiveness in investigating complex and imprecise phenomena. In this sense, many philosophers therefore suggest the idea of a general semantics in this field.

According to Caude's (1964) understanding, we could rightly ask ourselves whether the construction of increasingly complex or refined mental scaffolds would not be limited by the internal structure of our brain, for we are probably still very far from this limit since two-thirds

of the brain still appears to be unused. In the meantime, many equipment and devices prolong the activities of our senses, and relieve the work of the brain, as is the case with machines in general.

Caude (*idem*) reiterates his premise that the human brain, considered a universal machine of small capacity, with its few billion cells, always beats the most sophisticated machines, not only in instant memory, logical power, or calculation, but mainly due to its intuition, its potential for imagination and creativity. These are, therefore, mental faculties that formed the basis for the creation of concepts, representations, and conceptual systematizations, equipment, and machines that expanded and specified the scope of certain methods and even conditioned the creation and use of others (statistical methods, computational methods, varied models of representation and interpretation of data, measurement, control, etc.).

Still according to Caude (1964), the general method used in the production of knowledge consists of reformulating any problem, reexamining the data, restructuring them, classifying their elements, revealing their weaknesses, and then refuting them one by one until the problem disappears and their solutions emerge, thus demonstrating new knowledge produced. The mechanism of this thinking, based on the rational destruction of arguments, is linked to the "no" philosophy, addressed by Gaston Bachelard (1991), in the sense of using an "anti-logic". Thus, when applied to a new crossroads science, the methodology aims to master the complexity of our problems, examining all their characteristics, and trying to find methods that allow us to proportionate the result obtained to the efforts made.

The investigation of any problem is only truly possible if those responsible for it dedicate several efforts consistent with the results. To this end, the Methodological Study Group led by Moles highlighted around sixty (60) methods, whose nature is not limiting, but which represent a very extensive sample of the intellectual operations that any researcher should be familiar with and use in most situations they face in the planning and execution of their research. Later, I will briefly present some of these methods, considering his philosophy and aesthetics of the methods, and their current relevance, although they were enunciated at the beginning of the 1960s.

For Moles (1964; 1995), the word aesthetic means, in the etymological sense, the science of the perception of forms and structures: it is in this sense that it is linked to action techniques. To further clarify, we can consider that between the individual inserted in each social context and the external world on which they wish to act, there is first located this immediate structure which is the sociocultural context (sociocultural group), a means of action on the world, that at the same time sustains and overcomes this world. Thus, there is a high self-

correlation in the sociocultural world, in which events are at least similar to what has already occurred, that is, correlations are established involving what has already occurred, what is occurring, and what could occur.

We live in another rationality and we have to create other systems of thought. This is why we must refer to more fundamental and therefore more stable sciences, and not to techniques of action anymore, but to methods of reasoning, to more general sciences, to "sciences of sciences" and this is what justifies the term "Philosophy", not to mean that a philosopher strives to give unintelligible answers to meaningless questions. On the contrary, in the sense that they explain interpretations about the specifications of humanity in formation, through questions such as: What do we want? What will we do? and how do we direct our actions?

Thus, it offers us an applied and prospective philosophy, intending to build the present according to the future we want, instead of building it from the past, since from this past we explore the pieces that will structure the mental scaffolding that we imagine as the support towards what we want to achieve. In this way, our modes of action will make us reinvent the paths of search and the knowledge of the past will be renewed according to the future we want to achieve.

This research movement that involves past, present, and future, intertwining culture and methodologies. In this sense, Moles (1964) insists at first on the contrast between modern thought and classical thought imbued with Cartesianism, which was implicitly supported by this continuity of the human spirit. It means, then, admitting to placing ourselves before a phenomenon, with a sensation or a decision to be made, as an object of knowledge of the methodology we intend to adopt. We must, therefore, direct this object to our previous knowledge, to our memory, and to the concepts that characterize it, as if we were projecting this phenomenon onto a screen which Moles (idem) calls the screen of knowledge, which corresponds to the totality of everything we previously possessed in our memory.

Based on what Moles proposes, we interpret that there are centers of knowledge in this canvas, as well as crossroads concepts and general ideas, ways of bringing these concepts together, as main lines that start from them and intersect logically. Hence, teaching aims to provide us with these essential concepts, these lines of thought, called general culture, the most complete form of which is humanist culture. Based on this interpretation, we reflect on what we know so far about the topic and what thematic knowledge has already been produced. From this reflection, we move forward with our questions and methodological projection.

It means, therefore, that when we face any phenomenon projected on our inner screen, we use mental gymnastics of culture to connect this phenomenon to the great concepts, to the great general ideas, gradually incorporating it into the screen of our knowledge, to assimilate it, understand it and act on modern thought.

The canvas of knowledge offered to us has an essentially random structure. Our academic culture is not enough, mainly due to the variable existence of our school and, sometimes, university training. The structuring of this screen is much more influenced by the flow of knowledge we receive every day, permanent, disordered, excessive, and random information. Currently, this torrent of knowledge reaches us not only through the rational study of a book or listening to a series of conferences, but through the means of communication represented by the press or social media, in the contributions of ICTs, in other words, through a multiplicity of means that act *en masse* on us, such as current social networks and the most diverse information and communication technologies, which dominate us and from which we are left with only transitory influences, remnants of knowledge and fragments of ideas.

Even so, with all the information we receive, we often remain on the surface of things, since we are randomly impressed by facts that act with more or less strength on our minds. We do not exercise adequate reflection in the face of so much information, nor censorship, nor effort. Under these conditions, Moles (1964;1995) asserts that the canvas of our knowledge acquires a texture like that of a felt-tip pen, an item from our recent past: it is made of fragments, fibers of knowledge, elements gathered at random, one next to the other, without relationship. So, one individual will differ from another by the greater or lesser density of this sense of knowledge, even more than by the strength of the nodes in a network that no longer has real importance.

In this sense, Moles asserts that nowadays information and communication theory (ICT) tends to highlight the intellectual mobilizing collection of the human brain characterized as *bric-a-brac* (from the French *bric-à-brac*), that is, a set of information that in isolation seems to have low value or less importance, but when combined they continually generate new knowledge to inform and communicate thoughts and reflections. The same must occur when handling information explored in the research we carry out, to produce new knowledge about old or new objects of investigation. However, the difference in action lies in the sources, the handling of these sources, and the validation of the combinations, in alliance or alignment with the questions highlighted previously: What do we want? What will we do? and what are our modes of action?

For Moles (1964; 2012), however, this process is called mosaic culture, that is, a new way of generating or producing knowledge in which the contemporary 21st century world presents us with constant challenges. However, due to an education spent in environments with a different system from our current sociocultural life, we still have some remnants of Cartesian knowledge incorporated by this system. But in our relationships with other humans, we must always keep in mind that this image of knowledge stands in contrast to the relatively ordered knowledge of the Humanist Era that emerged, for example, at the turn of the 18th century to the 19th century.

Nowadays, this way of acquiring knowledge seems to us obsolete because we are challenged by three new factors - the vastness of information technology, objectively translated by the vastness of its vocabulary, techniques, applications, strategies, and methods, implying a variety of artifacts, mind facts and socio-facts[7] that are offered to us for a thought exercise based on combining information to generate other information that meets our needs in each moment. Such technical vocabularies, applications, strategies, and methods, among other components of this information web, are perpetually expanding and acquiring new meanings.

Based on Moles (2012), we consider it relevant to invest in this exercise of combinatorial thinking of information, taking it as a particular method of operational investigation in which the inventory of different ways of expressing a phenomenon, the search for definitions (content analysis, the statistics of the vocabularies used, applications used, strategies and methods of investigation and analysis, etc.) consists of the ways of apprehending a problem, to reach the extension and understanding of the diversification of the objects of our knowledge as well as what they refer to, generally speaking, to educational sciences.

Based on these previous assumptions, we admit that certain created methods experimented with or adapted from other fields of investigation acquire their value; in other words, the process of abstraction about what one wants to know - abstraction in the sense of understanding and appropriating the object of knowledge beyond its material, concrete expression – implies establishing it in its conceptual structuring in our brain. Therefore, it means that these concepts, combined in the form of mosaic culture addressed by Moles (1964), become important to express and validate the knowledge produced from the methods created and practiced while researching and writing the researcher's report.

[7] In this regard, see Ubiratan D'Ambrosio (1999) and Julian Sorell Huxley (1955), mentioned in the references at the end of this text.

Often, these concepts are what we turn to, even when they are increasingly distant from the immediate objects in our surroundings. This is because they are formed in our brains and thus require special effort from our mind, which is one of the main skills in mathematical science. Finally, we reiterate that they are the ones that reflect the randomness of knowledge and are related to the procedural movement of induction (as in mathematics) and that can be used to highlight the concepts that are important to compose the expression of knowledge that one wants to establish when writing about the knowledge produced, admitting the method as creativity in research in action.

Since the second half of the 20th century, the advancement of multiplicities of empirical research typologies in educational sciences (research in action), associated with methodological experiments in the teaching of school subjects, has led to the emergence of a range of results that have highlighted processes of creativity, imagination, abilities to synthesize and reinvent ideas. In this regard, in the 1960s, the Senegalese philosopher and psychologist Gaston Berger (1964) highlighted those inventing ideas is the most urgent attitude that the world imposes on us. The same emphasis is given by Teresa Vergani in the book Creativity as destiny, when she says that:

> man feels the need to understand the world and his personal experience, both rationally and symbolically. Symbolic understanding involves the activity of imagination, which is the root of creative force (Vergani, 2009, p. 101).

Therefore, we do not live in a worn out, tired world, which has already produced its most precious fruits but in a world which, on the contrary, never stops rejuvenating because it renews itself more and more quickly: it offers more and more powers and its appearance surprises us more and more every day. The supreme virtue then becomes imagination, which is not the disordered play of images, but an availability of the mind that refuses to be closed in frames that don't consider anything.

From what was mentioned previously we understand that Berger starts from the principle that not everything can be fully achieved or questioned, and he does that to clarify that this type of creativity in action is sought in the development of our research, based on methodologies or sciences of methods of action or reflection applied to the object of investigation to produce knowledge about that object.

Along the same lines of reflection, Teresa Vergani (2009) draws our attention to the fact that "Western science today is faced with the situation of opening up to two categories: what is *possible* and what is *likely to happen*. The statistical logical struggle against what is *likely to*

happen is over and a right judgment about an *objectively uncertain* state of affairs is sought" (Vergani, 2009, p. 54). Therefore, the notion of truth assumes the position of viability, that is, our object of knowledge becomes *objectively uncertain* since imprecision represents this openness mentioned by Vergani (2009) which requires other methodological validation practices in research that focuses on producing knowledge concerning the objects of the science of the imprecise. Similarly, Raquel Gonçalves-Maia (2011) asserts that:

> the scientist seeks truths – which should not be confused with the search for certainties – that are increasingly intelligible, with full recognition of the permanent fallibility of human knowledge. The same objective can be expressed in another way: the scientist looks for errors to correct them (Gonçalves-Maia, 2011, p. 193).

This kind of imprecise knowledge manifests itself spontaneously to the observer's perception as something that does not result from chance. If we receive a message from the external world it comprises a certain number of elements, signs, semantemes[8], fragments, symbols, etc... and its form is apprehensible in its entirety, immediately. This concept essentially involves the observer. This is a structure that Moles (1964; 1995) calls a mental (abstract) form, resulting from an active process on the part of the observer, that is, this structure establishes a support framework for the form proposed to us, based on the connection between factors that are rigid, more or less precise, more or less latent.

In such an active research process, an external observer who appears spontaneously in the process is provoked to project structures onto this research to carry out an analytical reflection of the factors; such a reflection will consider how the central aspects of this projection can shape or enclose it in a network of factors that will allow this observer to issue interpretations and reflections on their investigative, analytical and conclusive processing. However, care must be taken not to distort the representation of the investigated phenomenon when writing about it.

On methodology and imprecise method

Regarding imprecise phenomena, sociologists have historically been great experts on this subject, which still constitutes several of the dominant ways of structuring science in the organization of information about research involving humans, from the moment they adopted the mathematical concept of method to characterize human actions in all branches of

[8] It is part of a word that expresses a concept, an idea of exclusively lexical nature (substance, quality, process, modality of action or quality); radicals, simple words, compound words. It is the element that contains the meaning of a word.

sociological knowledge, including the first approximations provided by education and the use of school knowledge.

For Moles (1964; 1998), dimension is a mental attribute in the method: a descriptive and qualifying term that allows us to order and possibly measure the research object in a variety of dimensions. The only condition required is not to increase the number of these dimensional entities beyond what is strictly necessary during research. Therefore, in each dimension of a research object, we can characterize an order and a unit of measurement, however rudimentary.

At this point, we identify the originality of this mode of reasoning, which denotes one of the essential discoveries of contemporary research methodology. Thus, we can define anything by particular dimensions: objects, clocks, pens, workers, politicians, etc. The importance of these dimensions in the methodological choice for research on an object of knowledge will, therefore, be related to distance (generalized distance from the starting point to the arrival point, that is, the level of answer we want for our research question or questions). In this context we can arrive at a representation of the intended objects, an intelligible representation that can provide an opportunity to become aware of the object of knowledge.

But in the end, what is a method? For Moles (1964; 1998), the word method finds its etymological meaning in these reflections; for him, a method is a "road", that is, it is the form of a trajectory in space to represent the things we investigate. In fact, a method only exists in function of an intentional trajectory defined a priori, that is, in function of a particular form of trajectory as opposed to random wanderings, wanderings without repetition, without tomorrow.

Thus, we can say that, in addition to methods, there may exist a science of methods that will be a science of the trajectories of representative space, a geometry of actions, an intellectual system that integrates all the properties of these trajectories, resulting in the definition of good or bad trajectories according to a table of values, defined by Moles (idem) as an *ethics of thought.*

As mentioned previously, Valéry (1919; 2006) defines a method as a system of externalizable operations that does the work of the mind better than the mind and sees in it the beginning of a mechanization of thought, of an algebra of actions that serves as a preparation for the use of informational machines in which content is inserted that moves them according to given rules. It means using a pre-established program for its operation, such as many applications currently used in data mining and organization, and the creation of informational

computational models, such as predictive modeling, cluster[9] analysis, and association rules, as discussed by Silva (2015).

Regarding the content of a science of methods, Moles (1964) asserts that when we define methodology as the science of action trajectories from one point to another in the space of representation of actions, we begin to access the science of actions, which in turn corresponds to the awareness of the interrogative situation involved and we structure a methodology about the set of sciences, first trying to define their content and even more precisely, trying to make an inventory of this content.

In this sense, Moles admits that the method of graphic techniques, that is, graphic design, seems to be an elementary act of thought, and the presentation of graphic laws seems to have a particular meaning for the mind. Another method is to slice a reasonably large problem. This is a method that can be done in two ways: dividing the problem into several levels of attitudes: financial aspect, social aspect, technical aspect, psychological aspect, political aspect, or else, cutting a chain of logical reasoning into different stages that we study one by one like the links in a chain. There must be good and bad ways to proceed when making these two divisions, and a criterion must be sought.

Factor research is a more integrated method, that penetrates in depth beyond the external morphological aspect of the problem, as defined by a brief history or position statement, and brings to the surface abstract entities whose play reproduces this aspect. Another method is that of good examples, which is often extremely fruitful, gives rest to the spirit of abstraction, and excites our notion of intellectual comfort.

There is yet another method called teratological, where instead of looking for good examples, you look for paradoxical examples of the application of previously known notions to take the concepts to their *breaking point*, and thus grasp their solidity. It renews our mental attitude by playing on the strangeness of its claims and by forcing us to justify their validity. The method of definitions is classic, it consists of making, using, borrowing words and then looking for a definition showing whether they are hollow or full, heavy or light, rich or poor in associations.

The method of searching for keywords and strong ideas is autonomous. Whether true or false, main ideas have a universal aspect that makes them desirable. Keywords are words that appeal to our associative capabilities more than common vocabulary. They appear with

[9] Cluster analysis or data grouping analysis is an organizational technique that groups data according to their degree of similarity, so they are gathered into clusters. The objective is to use the clusters to define and analyze patterns.

abnormal frequency in interview-related questions and have a set of attributes commonly used in surveys to carry out bibliographical reviews, state-of-the-art or state-of-knowledge research.

The observation method is the one that renews the points of view of a sometimes not very competent, but intelligent spirit. Lévi-Strauss (2012) showed that it was one of Ethnology's main methods. Another method is the phenomenological study of a problem, the importance of which lies in trying to reduce it to its true nature. In the proposal of Moles (1964) and Moles and Caude (1970; 1977), each researcher is responsible for delimiting the contours of imprecise phenomena because action methods are often detailed examples.

On a classification of methods

A first classification of methods is presented in the book *Méthodologie ver une Science de l'action* (Moles et al, 1964) for there is a repertoire of important methods the mind employs to act, teach, and create, which constitute a rational collection of mind processes, but they must also be classified. Moles classifies them based on *intentionality categories*, that is, on a classification of the questions posed in the Philosophy of *Why? How?*, *As if*, *No*, and *Why not*, as defined by Bachelard (1991), and Moles (1998; 2007) in his book *The Scientific Creation*.

Table 1.

Philosophical classification of the methods scientific creation (Moles, 1964, 1998, 2007)

Ethics of thought	Methods	Infralogics used
The "As if" philosophy (A Law concept)	Recoding: Mathematization; Cybernetics: Application of a theory; Diagrams: Graphic Transfer Remodeling	Analogic
The "No" philosophy (Tendency towards opposition)	Contradiction; Critical; Review of assumptions (hypotheses)	Antilogic
The "Why" philosophy (cause)	Details; Synthesis; Emergency	Mythopoetics; Finalist Logic
The "How" philosophy (a Law concept)	Situation; Phenomenological reduction; Search factors	
The "Why not?" philosophy (combinatorial)	Mixture of 2 theories; Discovery matrix; Experimental mess	Continuity logic; Juxtaposition; Associationism; Verbal logic
The "Conventionalism" philosophy	Convergence; Classification; Definition	Formal logic

According to Chouleur, Feron, and Moles (1964), the classification of methods is sometimes based on their objectives: 1) a didactic one, which is a communication objective; 2)

a practical one, which is an objective of action; 3) a heuristic[10] one, that is, creating something new, and 4) a dialectical one, that is, a conflicting discussion in which one seeks to impose one's point of view, sometimes on the faculties of the mind to which it appeals, for example: abstract or concrete, theoretical or experimental, safe or risky, mathematical or verbal, etc... and we can try to place them about each other in this perspective that will determine how individuals will resort to them.

Still in this context, Moles (1964) suggests three main categories of intellectual processes to renew a problem or issue and pave the way for a solution. These mental methods used to fertilize the imagination and, above all, to break with habit or common sense, can be divided into three categories: 1) heuristic or discovery methods with applications especially in science and technology; 2) artistic methods with applications in fields where the conditions of coherence opposed by an external environment are not very constraining; 3) general methods that underlie most of the previous ones and, ultimately, resolve into a mental attitude.

The table for method classification presented below is not limiting, as it was a form of renewal proposed by the authors who are the focus of this essay. However, these methods were considered by us as technical devices that enable a rigorous delimitation of the treatment of research problems in each particular case but whose rigor will require control on the part of the researcher, according to a certain number of the researcher's criteria.

The work of the French Group of Methodological Studies suggested that we distinguish between the purposes that a method can achieve and the heuristic objectives of discovering something new, whatever its nature; the pedagogical objectives of convincing and demonstrating to another person, that is, communicating the obvious; the dialectical objectives of winning, imposing any point of view in a discussion or conflict (Rhetoric); and the pragmatic objectives of acting on technical or social reality to modify it.

Therefore, the set of 33 methods presented below was selected among more than 60 methods classified by the French researchers, to contemplate the great general methods in which each of the elements is only a more specific aspect. Likewise, another classification criterion was the nature of the techniques used. Several suggestions were made in this regard and were retained, among others: the relationship between imagination and tradition; the relationship between theory and experimentation; the relationship between synthesis and analysis; between

[10] Derived from the Greek word “heuristiké”, heuristics is the ability to discover and invent. Thus, it represents the way in which human beings simplify the understanding of complex issues, whether because they need to decide based on incomplete information or because they find themselves in situations of uncertainty.

abstract and concrete and between security and risk. Table 2 shows the classification of the methods proposed by Moles (1964).

Table 2.

Classification of methods. elaborated from information extracted from Moles (1964).

Nº	**Method**	**Characteristic Synthesis**
01	Application of a theory	Based on a completely abstract mathematical or rational theory that we can enunciate, it is applied to a given real problem to validate the solutions found
02	A combination of two theories	It is a theoretical method that explores two distinct abstract or mathematical theories to bring them together in search of a solution to a particular problem (heuristic method and discovery matrix).
03	Assumption Review Method	Uses a critical mindset on the basic hypotheses, experimental data, and proposed articulations of reasoning, to resume and expose all explicit or implicit assumptions underlying rational development, to identify dilemmas, paradoxes, or errors, correcting them and completing reality.
04	Critical method	An epistemological synthesis is made that the researcher will show does not apply to the phenomenon that is the focus of the research. It does not criticize the nature of the hypotheses formulated or how the reasoning and its articulations are detailed. The result makes it possible to propose another theory when the process is repeated a certain number of times.
05	Remodeling method	This method consists of stating that at each stage several factors must be taken into account, starting from hypotheses and following the path from ideas and demonstrations to the results found.
06	Definition method	This method is based on a principle of authority, on establishing definitions; it can also be a real method for defining and delimitating notions that could have seemed confusing before.
07	Etymology method	This method clarifies certain questions and eliminates certain confusions, as a better knowledge of etymologies makes it possible to avoid such confusions in the understanding of concepts relating to the investigated phenomenon, considering that etymology serves as support for a certain number of more or less precise ideas linked to the phenomenon. This method allows the researcher to verify the etymology related to the terms of the problem, starting, in a historical way, to compare ideas and their developmental transformations.
08	Translation method	Based on the etymological method, to translate means leading from one language to another. This is a remarkable extension of the claim that words preexist ideas, not ideas preexist words. When we have a few ideas and only one word, we can fertilize the mind by searching, in all the "languages" we know, the translation of this word to see if the constellations of attributes it implies are different, and thus we can multiply them.

09	Concept transfer method	It means taking a vocabulary (or a cluster of terms) from a certain field of thought or experience and transposing it to a field where these words are not used, asking whether it would be possible to give them, in this new field, a precise meaning and definition. An example is the use of words such as “noise”, “distortion”, and “diaphonic” from the science of acoustics and communication being transposed to sociology, in which messages also circulate between individuals; “Distortion and noise” in this new field mean an equivalent and precise notion in the human sciences that no researcher had thought of.
10	Analog Transfer Method	The examination of a phenomenon with the concerns and from the angle of another phenomenon. This is the great principle of analogy as the first stage of abstraction, as it combines several phenomena under the same mental mechanism, before completely releasing this mechanism. Sociologists were informed that the concept of social chemistry defines an important branch of science. The words "valency" of attraction and reaction, of "molecules of social atoms" were naturally defined by analogy.
11	Method of Matching between theories	At a certain stage in the development of a scientific theory, researchers sometimes discover a certain parallelism in their approaches. The awareness of this induces them first to systematize it and, therefore, to verify this correspondence as much as possible, then to explain it, reducing the two theories to one.
12	Lawyer method or opinion method	This method consists of the collection and conjunction of arguments for the benefit of the investigation and analysis that one wants to carry out, taking into account a dialectical and rhetorical position that the researcher must assume when bringing substantial material to their research archive, whether they come from one or the other part, contributing in any case to the progress of the research question. The value of the method lies in crediting a theory with everything that had to be done to demonstrate that it was false.
13	Arenarium Method (from the Latin “arena” beach, sand)	It consists of a problem of validity or capacity for action, of establishing limits in order to exceed them. It is related to the method that Archimedes used to demonstrate the infinity of numbers, saying that if he took all the grains of sand from all the beaches in all the countries in all the worlds, he would always be able to state a number greater than this, simply adding a grain of sand to it and starting over. It is very useful for defining content with an obvious field of validity and for finding endpoints of a search, to extend, by successive extensions, the areas already explored by previous searches, that is, part of a result already validated for a given problem, as an *a priori* truth, aiming to expand the conclusions, returning to the conditions imposed at the beginning, in the form of induction in reasoning.
14	Limits method	It presupposes that research has the vocation of eliminating already established limits and that investigative thinking must assume the process of producing knowledge is a continuum to be expanded. This method is the equivalent of specifying the distinction between the

		"inside" and the "outside", successively proposing the notion of membranes, as in the theory of membranes in biology. It also corresponds to the transformation of a qualitative process into a quantitative method, since an infinite number of possible intermediate solutions can be found, but all require a certain capacity for slow thinking and a minimum of critical thinking to analyze such solutions.
15	Small variations method	A method used to detect structures to analyze their elements as an elastic or semi-rigid system, in which any modification at one point will have repercussions on any other point, thus revealing the underlying structure drowned in appearances. It is very suitable in the search for hidden structures in an object of social research that often wants to see the reciprocal solidarities between the different parts of this social organism, in search of residual correlations.
16	Sizing Method	It is a method proposed when dealing with a set of phenomena, in which the researcher will seek to place them in any continuum, that is, to find increasing characters among them. The researcher imagines a universal arrangement characteristic and chooses the one that best separates the phenomena they intend to analyze. This method is widely applied in content analysis, science classification, etc.
17	Phenomenological Method	Phenomenology is the study of phenomena and thus it is initially required to separate aspects or points of view about the same phenomenon. This method suggests inverting the phenomenon, isolating it from its context and its surroundings, extracting it from the environment while becoming aware of the links it has with the context, reducing it to these essential aspects, that is, reducing a phenomenon or appearance to essentials, and thus renew the aspect offered to the observer, giving it a new strangeness.
18	Teratological Method	It consists of choosing a paradoxical, extreme, bizarre, shocking, scandalous example, which takes notions to their limit of validity and thus helps to define them. Extreme examples have heuristic power in themselves, because they reveal the limits of reasonableness. However, this method generally has a pedagogical and rhetorical purpose to highlight theoretical and empirical contradictions in research during data organization and analysis.
19	Dichotomous separation method	The central focus is to show that the human mind proceeds through a series of successive statements that create a branched network given that, when faced with a given problem, we ask a series of yes or no questions (dichotomy) to try to translate it into intelligible terms. This method lends itself well to mechanization, as it deals with the mind's translation of fluid reality into quantified categories. It is a method of creative observation, since all work represented by the establishment of a characteristic archive of phenomena or just one of these phenomena, in computational systematizations, requires a final dichotomization of the investigated reality. For this, the observation is quantified, achieving an understanding of the real factors of the phenomenon.

20	Details method	It is a method for meticulous research that seeks to deepen studies on facts whose explanations still seem incomplete. Given a general explanation, the researcher will check whether or not all the detailed points of the phenomenon are well explained before they can resume the explanation. It systematically searches for details, but first, it looks for clues that allow it to dismantle all existing explanations for the phenomenon.
21	"New eye" method	This method transfers the explanations explored by perceptions to the experimental field, which means it amplifies the field of the phenomenon's detailed explanation with an experimental basis. This method allows us to get closer to the phenomenological study that seeks to clarify what seems to be strange as the qualitative value of a usual phenomenon. Journalists and investigators often use these procedures.
22	New equipment method	It is derived from all methods based on point-of-view switching, as this is the typical attitude found in a laboratory when receiving a new device; There is a certain freshness of mind in the face of new properties, so many researchers consciously explore the device that offers a whole new range of possibilities. It is not always the case that the new equipment was purchased for a perfectly defined purpose. Therefore, there may be new applications that were not thought of by their creators. Examples of this method are the uses of calculators, computer programs, and applications, as well as all complex devices, in which there is a kind of creative power that complexity brings, which has not been highlighted before.
23	Discovery Matrix Method	This is a general method denoting a kind of sizing from the moment any kind of ordering for a certain number of characteristics corresponding to (physical) phenomena is imagined. We can ask ourselves what the actions of these phenomena are on each other, that is, to practice a combination.
24	Reciprocity method	It is a method derived from the discovery matrix, in which the operator acts on the operand and vice versa. Some 19th-century physics made great use of this method. In the human sciences, this attitude of reciprocity is considered to be found in the most diverse cultures and societies, being something universal. Therefore, it is an adequate method for sociocultural research such as educational sciences (teacher-student and vice-versa; teaching-learning and vice-versa, etc.).
25	Latent structures method	It deals with relationships that must exist a priori between the different factors of a phenomenon, whatever the origin of this knowledge. This method is related to the principle of recoding, according to which the manipulation of concepts is one of the keys to thinking and expressing the phenomenon in another way opens the possibility of updating the heuristic potential in this regard.
26	Representation form method	It is a method for recoding, and re-presenting reality, a position occupied by human intelligence. It deals for example, with the way representations work in the design of organizational charts in research

		or the structuring of its final report, and also in the design of multiple computer programs, among other graphic representation systems currently used.
27	Diagraphic method	This method derives from the previous one. In practice, it corresponds to a subsequent stage of schematization and, therefore, abstraction. The organization chart is in itself an abstract breakdown of the reality of research, but from this organization chart properties verified (or contradicted) by practice will be deduced. After taking a step towards apprehending reality, we can go further in this same method and re-present it in an entirely symbolic universe.
28	Graphical induction method	It is an important method derived from the previous one, in which we try to describe intelligible forms of a phenomenon. To do this, two or three characteristic quantities, that is, measurable physical aspects, are introduced, and we will systematically trace the variation curves of these quantities depending on each other. Under these conditions, these curves become forms linked to the phenomenon and more or less relevant to its hidden essence. Some hypotheses will then be available to interpret the simplest curves (linear increase, decrease, exponential variation, asymptote and saturation, cyclic phenomenon, load mountain, etc.).
29	Good examples method	This method is based on systematically searching the purpose of condemnation or exposure to an objective witness, who acts as a mirror, of a very specific case in which some meaning applies. In this case, we will often go from theory to reality, not the other way around, but a good example circumscribes a certain number of phenomena and sometimes forces us to reflect to purify them of adventitious factors.
30	Historical method	It is a didactic and expository method. When faced with any fact that must be communicated in detail to someone, we start from the axiom that there is certainly a path to explanation, at least the one that has already been followed in its historical development. To present a state of affairs to an audience, instead of explaining it by resorting to effective latent structures, one can, through persuasion, remain on the surface of things, presenting the history of the problem, thus presenting again a temporal sequence of situations starting from the belief that each state is determined by the previous one. This is one of the most common processes in presenting a scientific theory to laypeople.
31	anti-historical method	It is the opposite of the previous one, as it is based on the idea that the frames of history are not the real frames of thought and that if it is possible to go from point A of the heuristic field to point B, redoing the entire set of trial and error of the discovery, it is not desirable to do so. This is not ideal and there should be shorter and, for example, more logical reasoning. Once the structure of history is eliminated, the mind will be forced to discover the real factors, prohibiting the continuation of history's temporal trial and error.

32	Measurement method	A method naturally linked to that of sizing because when faced with an unusual and uncertain phenomenon, as to what could be done about it, researchers free themselves from their indecision to extract measurable magnitudes from it, ordering the aspects of the phenomenon to a certain extent without having any illusion about the arbitrariness of what it measures. When we don't know what to do, we can always measure, even if it means discovering later that what we first measured was not the true expected quantity but a part of the initial process in a path that we draft as we are treading it.
33	Incompetence method	This method is based on the analysis of the role of criticism, based on the observation that specialists incorporate, in their competence, a certain number of critical points of view necessary for the normal exercise of their expertise. But those considered incompetent do not run this risk and can therefore bring new points of view that are all the more valid. It means that if we gather the opinions of lay people on a given subject with the hope, verified by experience, that if, out of a thousand ideas given, only the thousandth is valid, perhaps the analysis will be different from anything an expert could have imagined.

To conclude

Bearing in mind the discussion in this essay, it is possible to admit that the set of methods of action, reflection, exposure, or discovery discussed here and presented in Table 02 is far from being exhaustive, as there are currently other methods and, in this essay, we present only a part of them (the half proposed by the authors studied). However, the intention is to suggest possibilities of highlighting thought processes towards action that are entirely independent or little dependent on the methods established by classical, logical philosophy, which constitute a "logos" of scientific creation. We emphasize that all these methods are random and emerge from the object, the problem, and the research questions when associated with the theories supporting research in the sciences of the imprecise.

Therefore, the success of these methods is never fully guaranteed, since they are not effective recipes to infallibly reach the desired result, without alignment with the other pillars supporting the production of desired scientific knowledge; in other words, there is no invention machine, but rather mediating parameters to move towards achieving the desired research objectives. However, broader knowledge of varied intellectual attitudes, underlying the methods discussed in this article, can renew the imagination sterilized by the methodological

tradition established by the sciences of certainty, sometimes stagnant, either by habit or by a very narrow field of experience.

The differentiation of these methods presented by the authors, still at the turn of the second half of the 20th century, is far from being rigorous or definitive, as many overlap or participate in similar investigative attitudes in different structures. It seems, however, that following part of the cartography of elementary methods presented by the authors, an affiliation and grouping could emerge from other methods, even more vague, although much more powerful, but in a relatively limited number.

Given this context of final reflection, I consider it possible to indicate a few attitudes towards a possible affiliation of researchers with the methodical framework presented, such as:

a) To prepare a research scenario that includes phenomenological method, scenario, change of scenario, or definitions, experimentation to see, etc...;

b) To recode research processes that involve: graphical methods, flowcharts, infographics, schematic descriptors, and image diagrams, among others.

c) To reflect on the intellectual constraints involved: sacrifices made, dichotomization, etymology, etc...

d) To process iterations[11] involving: area, recurrence, successive filters, etc...;

e) To establish combinations to create discovery matrices in the analysis of information obtained in the research.

f) To explore the field of possibilities expressed by the discovery matrix and other open epistemic territories, etc.

g) To promote experimental and reflective continuity through criticism of the results obtained in iterative processes developed in research, etc...

These are some of the possible attitudes indicated after the studies we carried out, which seem to represent the underlying factors of the investigated material, whose expression is given by the philosophical attitude of the researchers to the extent that they practice each of the proposed methods in accordance with the research problem presented in their projects. It is the

[11] Means programming repetitions of one or more actions, as each iteration refers to only one instance of the action, that is, each repetition has one or more consequent iterations that constitute the cycle of repetition and accumulation of experiences to prove hypotheses about arguments stated in the search.

study and exercise of these methods that can reveal their implementation and in what terms they can be taken at the level of the organization and can give rise to a technology of methods proposed or suggested by the group of French authors, to researchers who must solve a problem in their research in the context of the sciences of the imprecise.

In general, these methods emerged unstructured, and so they must continue; they remain – and must remain – unstructured so as not to become recipes, which would make them lose their power of scientific creation when they acquired precision– as highlighted by Moles (1998) – because imprecision is the key to scientific creation, with creativity in the use of these methods. Therefore, it means that creative invention in research is operationalized in the dark, in that which is vague and unintelligible. These research methods take on an aspect that has more to do with the *ars conjecturandi*[12] defined by Jacques Bernoulli in 1713 (1692), than with exact science, as highlighted by Ian Hacking (2005) when he asserted that there is no distinction between inference under uncertainty and theorization, that is, the distinction can be accentuated by contrasting logic with observation and experimentation.

Therefore, creation, imagination, or invention remains a kind of art to the extent that they produce what is new, which is the meaning of making science as art. However, art cannot be reduced to pure chance, since one must dream and imagine creating, though without losing reason.

Acknowledgment

This article was the result of research supported by the CNPq through the Research Productivity Grant and by the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES), in support of postgraduate research.

References

Bachelard, G. (1991). *A filosofia do não: Filosofia do novo espírito científico* (5a ed., J. J. M. Ramos, Trad.). Lisboa: Editorial presença.

Berger, G. (1964). *Phénoménologie du temps et prospective*. Paris: Presses Universitaires de France.

Caude, R. (1964). La méthodologie : Caractères généraux et applications. In A. A. Moles & R. Caude (Orgs.), *Méthodologie vers une science de l'action*. Paris: Gauthier Villars Éditeur.

[12] The art of throwing or playing, of going in search of that which is probable, viable.

Chouleur, J., Feron, R., & Moles, A. A. (1964). Essai de classification des méthodes: Introduction a une taxonomie des méthodes. In A. A. Moles & R. Caude (Orgs.), *Méthodologie vers une science de l'action*. Paris: Gauthier Villars Éditeur.

D'Ambrosio, U. (1999). Literacy, matheracy, and technoracy: A trivium for today. *Mathematical Thinking and Learning, 1*(2), 131-153.

Farias, C. A., & Mendes, I. A. (2024). *VII Escola de Estudos Avançados: Pesquisa em cultura, história e educação* [livro eletrônico]. Belém, PA: Edição dos Autores.

Gonçalves-Maia, R. (2011). *Ciência, pós-ciência, metaciência: Tradição, inovação e renovação*. São Paulo: Editora Livraria da Física.

Hacking, I. (2005). *El surgimento de la probabilidad: Un estudio filosófico de las ideas tempranas acerca de la probabilidad, inducción y la inferência* (J. A. Álvarez, Trad.). Madri: Gedisa.

Heisenberg, W. (2009). *A ordenação da realidade* (M. A. Casanova, Trad.). Rio de Janeiro: Forense Universitária.

Huxley, J. S. (1955). Evolution, cultural and biological. *Yearbook of Anthropology*. Chicago, IL: University of Chicago.

Lévi-Strauss, C. (2012). *Antropologia estrutural* (B. Perrone-Moisés, Trad.). São Paulo: CosacNaify.

Moles, A. A. (2012). *Sociodinâmica da cultura* (M. W. Barbosa de Almeida, Trad.). São Paulo: Editora Perspectiva.

Moles, A. A. (1998). *La creation scientifique*. Geneve: Kister.

Moles, A. A. (1998). *A criação científica* (G. K. Guinsburg, Trad.). São Paulo: Editora Perspectiva.

Moles, A. A. (1995). *As ciências do impreciso* (G. de C. Lins, Trad.). Rio de Janeiro: Civilização Brasileira.

Moles, A. A. (1990). *Les sciences de l'imprécis*. Paris : Éditions du Seuil.

Moles, A. A., & Caude, R. (1977). *Creatividad y métodos de innovación*. Madrid: Editorial: Iberico Europea de Ediciones.

Moles, A. A., & Caude, R. (1970). *Créativité et méthodes d'innovation*. Strasbourg : Fayard-Mame.

Moles, A. A. (1964). Le contenu d'une méthodologie appliquée : Un essai de liste analytique des méthodes. In A. A. Moles & R. Caude (Orgs.), *Méthodologie vers une science de l'action*. Paris: Gauthier Villars Éditeur.

Moles, A. A., & Caude, R. (Orgs.). (1964). *Méthodologie vers une science de l'action*. Paris: Gauthier Villars Éditeur.

Silva, L. A. da. (2015). *Mineração de dados: Uma abordagem introdutória e ilustrada*. São Paulo: Editora Mackenzie.

Valery, P. (2006). *Introdução ao método de Leonardo da Vinci* (1919) (G. G. de Souza, Trad.). São Paulo: Editora 34.

Vergani, T. (2009). A criatividade com destino: Transdisciplinaridade, cultura e educação. In C. A. Farias, I. A. Mendes, & M. C. de Almeida (Orgs.), *A criatividade com destino: Transdisciplinaridade, cultura e educação*. São Paulo: Livraria da Física.