DOES MULTIDISCIPLINARITY MEAN MORE THAN INTER-, CROS-, AND TRANSDISCIPLINARITY, BUT WITHOUT BEING EQUAL WITH HOLISTIC APPROACH IN MODERN APPLIED SCIENTIFIC RESEARCH?

Gheorghe Săvoiu

Romanian Statistical Society, Bucharest, e-mail: gsavoiu@yahoo.com

Abstract. *Abstract. Mathematics as the scientific discipline together with its mathematical signs as language can offer a good starting point in an attempt to find reasonable answers to such a difficult question or to such a long paper's title. Some assumptions, hierarchies and levels of importance generate in Mathematics the most realistic solutions for the beginnings of scientific knowledge and the rational dialogue. Other voices believe more in Logic. This aspect is not so important for this paper, but it can be maybe for a future volume of ESMSJ. The article tries to find a valid response and to motivate it, to the general question like the following: Does multidisciplinarity mean more than inter-, cross-, and transdisciplinarity, but without being equal with a holistic approach in modern applied scientific research? And if this paper offers a false answer or not, only the readers can say to the end of this changing words into new significances and concepts…*

Keywords: interdisciplinarity, crossdisciplinary, transdisciplinarity, multidisciplinarity, holistic approach, scientific language, scientific research, Mathematics, Statistics.…

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1. INTRODUCTION

A researcher can say that Mathematics is not a science, but certainly, he must admit the most used and validated language of many other sciences is the mathematical one. Or even more tragic, a great majority of mathematicians can believe sciences are not real outside the frontiers of their mathematical scientific language.

And above all of these aspects, there still exist some young or old researchers who have some major reasons to think this is not relative truth. If one tries harder, he really can find some justified reasons to arrive at this specific way of thinking: i) the mathematical language is alive even today, and not dead (i.e. the live Mathematical language versus the dead Latin language); ii) the alphabet of Mathematics enlarges or expands its dimensions day by day; iii) the significance of each mathematical sign is more and more developed, multiplying its nuances; iv) the past apparent limits of some classic mathematical operators or operations seem to disappear in the present or, in the worst case, in the very next future; v) the sciences without mathematical validation are difficult to believe, etc. One logician can say that only logical language can realize all of these things, etc.

Let us consider together these distinct aspects as a futile or indubitable demonstration of the superiority of mathematical language, and, finally, one researcher will not use any other language at all, and thus will forgive soon everything else even his scientific or native language. Could this idea be an entirely false hypothesis for a mathematician?

On the other hand, an increasing interest in multidisciplinary analyses has been registered during the last decades, particularly due to their potential unbounded area for scientific applications. Indeed, the inter-, cross-, or transdisciplinary concepts are frequently met in all scientific research areas, covering day by day too many fields, spanning from computer science to medicine and social psychology. Moreover, apparently and specific concepts and methods prove to be a reliable bridge between the natural and social sciences, so the recent interest in the inter-, cross-, or transdisciplinary field can be considered anytime fully justified (i.e. based on the strong methodological experience of the statistical methods and mathematical calculus and theory, new applied multidisciplinary papers are published each year, mainly focused on the dynamical, structural and territorial evolutions of populations of any kind, from all the science. A new way of thinking called DoE - demography of everything – can be considered also a new tendency in statistical and mathematical common researches.

The remarkable extension of scientific research started from the concept of (***mono) disciplinarity,*** as specific captivity of isolated reasoning, generated by standardized and obsolete concepts (cognitive biases), but also by the captivity of outdated classical theories or by some canonical methods and practically unusable (methodological biases) or even by some traditional models that have already acquired increasing residual errors (modelling biases) [1-3], and developed to:

a) ***interdisciplinarity,*** as permanently and extensively (re)drawing the contour of knowledge and imposing cohabitation in the interstitium between different disciplines in scientific knowledge, being also a disaggregated expression at the beginnings or in the process of delimiting the common area, to finalize the aggregative nuances in case of completely different scientific research area [4-5] or to

b) ***crossdicsiplinarity***, which manifests itself in the alternative forms of

   b_1) ***simple crossdisciplinarity***, where a method specific to one science is applied in the body of another science, concerning the source of origin or

   b_2) ***complex crossdisciplinarity***, when several methods are aggregated and capitalized analogously [6-7] and even to

c) ***transdisciplinarity,*** *as a superior form of inter-, and crossdisciplinarity that involves concepts, methodology and language tending to become together more universal and stable, transdisciplinarity generated dynamically, through the action of multiple levels of reality (information theory, scientific modelling theory, systems theory etc.)* [8-9].

All of these new variants of research allow the development of ***multidisciplinarity*** as a complex theorethical solution to approach the knowledge by reality, the most efficient investigation or the best way of modern research to bring together many individual sciences as Logic, Mathematics, Physics, Statistics, Chemistry, Philosophy, Medical Sciences, Sciences of communications, Biology, Economics, Social sciences etc.

Statistical Physics provided the most interesting model of interdisciplinarity, as soon as possible transformed into multidisciplinarity. The real cause of this transformation consists of its capacity as the first form of differentiated and generalized physical thinking, but the further development from the initial first rank of interdisciplinarity to multidisciplinary approach was discontinued in its natural evolution by the general scientific immaturity of the same XX century. It is the specific thinking way of Statistical Physics that lies the first argument of the evolution of statistical thinking in contact with other disciplines such as Physics to others like Economics or Sociology, which were less likely to generalize or maximize the coverage of their specific meditation in immediate reality. [10]

This argument represents the exceptional contribution made by Josiah Willard Gibbs (1839-1903), who was also called the "*father of Statistical Physic*s"; he authored the book *Elementary Principles in Statistical Mechanics*, published by Yale University in 1902. It was also Josiah Willard Gibbs who simplified, as only a pragmatic, inimitable and thus genius-like thinker could, the way of thinking and working of the physicist, although at that time there were fewer than 1000 physics university graduates worldwide.

"Introducing a geometrical representation in the character of substitution of the experimental referential, which later became the famous *Gibbs space*, which reduced the macroscopic world to the microscopic one, the "*father of Statistical Physic*s" transformed the finite world of a very large number of particles ($n \cong 10^{23}$ particles) located in a real space, into a single elementary particle (a point), placed in an area of *2n* dimensions. The Gibbs space resulted from turning the *2n* coordinates and generalized impulses (p_i and q_i) into the coordinates of a single point located in the *2n* dimensions space, which was also called the *phase space*, starting from the fact that the *2n* coordinates and generalized impulses determined the microscopic state of the system, or the representative point in the *2n*-dimensional space, or a microscopic state, or a phase of the system…

Thus, using Statistical Physics, for the first time the macroscopic properties of equilibrium of the systems could be explained, based on microscopic structure, and, again for the first time, both state equations and the dependence of material constants on microscopic parameters were deduced, in a circular manner. Statistical Physics would, later on, find that, starting from the fact that between the description of macroscopic states and microscopic states there is no bi-univocal correspondence, i.e. knowledge of a microscopic state univocally leads to the knowledge of the macroscopic state, while the knowledge of the macroscopic state can lead to a lot of compatible microscopic states, reaching a very important conclusion in the research of statistical populations: knowing or fixing the macroscopic state through macroscopic system indicators (parameters such as pressure and temperature in Physics, the character in Psychology, price or wage in Economics, population density in demography) can never allow knowing a certain microscopic state (since a huge variety of microscopic states are compatible with the values of the parameters of the system).

What Statistical Physics, however, found almost instantly was that for a given macroscopic state of equilibrium, any of the microscopic states are realized with probabilities completely determined by the values of the macroscopic parameters. The macroscopic state does not determine, separately, microscopic states of the system, but rather probabilities with which these states are realized in the macroscopic system." [10].

The essential role was assumed by the *probability density on the Gibbs space, or the space of the phases*, a density able to fully describe a new type of state, called *statistical state or assembly state* (and the logical refinement thus became evident).

Knowledge of macroscopic parameters was suddenly possible with the definition of probability density. To better understand the intrinsic connections between the modes of thought that had to be integrated into the statistical thinking to modernize its scientific "*meditation*" belonging to the scientific type, it would be useful to remind that Irving Fisher (1867-1947), the father of American neoclassical economics, the statistician who authored the ideal index, and also the trainer and moulder of the new generations of statisticians who developed the thinking that shaped statistics by founding econometrics (at once with establishing the famous Econometric Society along with Ragnar Frisch, Charles Roos, Harold Hotelling, Carl Snyder, Ladislaus von Bortkiewicz, Arthur Bowley, Joseph Schumpeter, Norbert Wiener and others) was a student of Josiah Willard Gibbs, and, perhaps the most important aspect, his doctoral student. [10]

At the beginning of the XX century, the statistical thinking from real scientific research benefited only partially from the original thinking of Statistical Physics, that is the comparatively little that could be taken over from Josiah Willard Gibbs's thought as that moment (in fact, nearly half a century was to pass before Ettore Majorana applied it for the first time to economic statistics, for example).

Post-paradigmatic and variational statistical thinking, though already incorporating inter-, and multidisciplinarity in the theory of probability and survey, would have evolved in a limited manner, without the support provided by generalized fuzzy logic, remaining a mere and partial application of Statistical Physics. Statistical Physics and the fascinating synthesis of Josiah Willard Gibbs's space

were discontinued in their natural evolution, very much like a long-expected interdisciplinary to multidisciplinary invasion, by the overall scientific immaturity of the time, since Statistics failed, after its first phase of modernization, to make the methodical inferencing, providing modelling towards Economics, Psychology and Sociology, while Economic Statistics did not understand its long-term impact, etc.

"The modus ponens in the classical type of logic and mathematics gradually becomes a modus componens, dominated by Gestalt (system or whole), oriented towards an integrative and holistic thinking, the more flexible and more rigorous type of thinking of modern statistics in its final phase of development to Statistical Physics" [10]

Even the field of the possible applications of the multidisciplinarity seems today to be unbounded, multidisciplinary research becoming a reunion of the way of thinking of a large variety of disciplines engaged in a certain line of specific inquiries or investigations to a problem, a timeline, a region, a structure, a system, etc. Thus, the individual results of the (mono) disciplinarity is better compared with any of the specific concepts techniques, methods of any of the distinct or isolated disciplines only because these disciplines are brought together in an aggregate. Modern research and knowledge, therefore, tend to be frequently multidisciplinary in nature, models and results.

According to the modern trends in the creative application of multidisciplinarity in various scientific researches, and validation of new models of investigations in the existential space of other types of scientific knowledge concerning those multidisciplinary concepts, techniques, and methods that generated them, modern researches supplement investigation by its psychological communication inside the multidisciplinary teams and projects. Holism or holistic approach can identify ideally with the *to-the-extreme* form of complex multidisciplinarity, defined as educational (academic) purposefulness, in the explosive sense of an ample dissolution of all disciplines or sciences into one, a complex fusion into a huge scientific universe (epistemological multiverse) [10].

2. WHAT A HOLISTIC APPROACH MEANS IN MODERN RESEARCH?

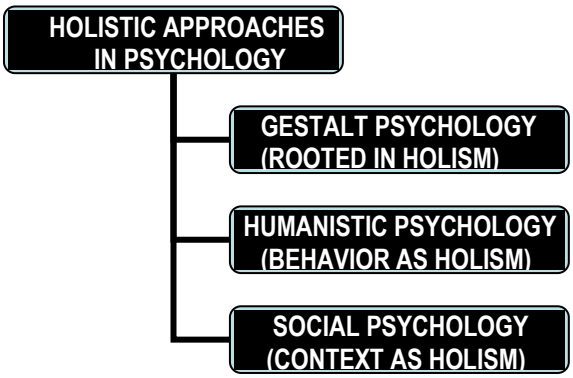
A lot of differences appear between *holism* and *holistic approach* from the point of view of dictionaries significances or definitions. *Oxford English Dictionary* defines ***holism*** as "*the tendency in nature to form wholes, which are greater than the sum of its parts, through creative evolution*". [11] The major aim of a ***holistic approach*** in medical researches represents a promising evolution in the model of the investigation and a stable solution that can be extrapolated and used in the future based on the opinions of many experts (researchers) from as many scientific disciplines as possible for the moment [12].

Joshua Freeman offered an expressive and elegant difference between the definitions of holism and holistic approach, based on health researches and medical sciences: "the very concept of holism as a single '*holistic therapy*' is oxymoronic; at best there can be a holistic approach, combining, when needed, a variety of therapies." [13] Rather than looking at individual sciences and experts (researchers) and their approach matters separately, a ***holistic approach*** integrates parts of each vision and scientific theory into the general program of investigation [14-16].

In Psychology, the idea of a ***holistic approach*** is focused on understanding the human mind and behaviour, looking at all known things as a whole. In any holistic approach, it is important not only to view the research, from object or domain to results, as a unit, rather than trying to break it down into its isolated parts, *but also to believe that it is more important to look at how all the disciplines work together in a common scientific research* [17].

To a better understanding how researchers think, in any holistic approach, one needs to do more than simply focus on how each component functions in isolation, the key phrase summarizing the key idea behind the holistic approach being similar to holism major significance in any dictionary "*the whole is more than the sum of its parts"* in any gestalt phenomenon. [18-19]

The final appeal of holism offers to any researcher the chance to validate or not his abilities to incorporate all of the elements that make populations who real individuals are, more or less. Either population or the individuals are infinitely complex and varied, and many times only a holistic approach is able indeed to address the external and internal factors that influence not only past, but also present, and especially future. [12]



Source: Realized by the author from [20-21].

Fig.1. Some examples of the holistic approach in the major branches of Psychology

A holistic approach of any domain of knowledge can establish the essentiality of real holism and is rooted in holism indeed, materialized in social context, communication and behaviour as in Psychology's example (Fig. 1). The process of holistic approach includes two permanent elements: model and data discovery using input/output matching.

The process of a holistic approach has been supported and consists of two main principles:

i) holism and holistic approach are defined by *the inclusion of all the necessary* disciplines, parts, all the different connections and associations, all the various aspects or parameters versus multidisciplinarity, which is

the partial integration of some common disciplines, theories, methods, models and data, concepts, defining completely different the initial and final spectrum of the same research;

ii) holism and a holistic approach must be *completely and systematically organized* versus multidisciplinarity, where researchers' questions of major interest in are to evaluate how can be extracted the essential aspects, *organizing* observed data into meaningful phenomena [22-23].

These are only two major differences based on specific principles and characteristics only, and holistic approach remains always the final stage or destination of any specific or distinct evolution in multidisciplinarity. By looking at phenomena holistically, researchers can provide or even can address all of the many factors that might affect reality, including different populations, and especially the environment.

Using multidisciplinarity any scientific research can obtain not only a better image of reality, compared or confronted with the unidisciplinary research but also a profound and intense investigation. Multidisciplinarity remains just the way of research, while a holistic approach is always the destination or endpoint of any complex scientific research, in general.

3. CONCLUSIONS

In this paper, I have tried to underline the major changes of the dimensions of the scientific territory and the methodological structures of new applied multidisciplinarity knowledge and research and how these can be "connected" to the whole system of the scientific knowledge and scientific research, known together as the holistic approach.

The most important conclusion is drawn in the vitality of the new multidisciplinarity tending to the holistic approach, but only after emphasizing the main gains of inter-, trans- and crossdisciplinarity together in any possible scientific domain or even into science formalism. This major conclusion means identifying new characteristics of advanced or complex multidisciplinarity (A&CM), from an increasing explanatory power to an unlimited intuitive understanding, coupled with the possibility of using new analytical methods, in addition to the ones existing in the actual scientific literature. The best example is coming from the field of holistic medicine, which "*focuses on treating all aspects of a person's health including physical symptoms, psychological factors, and societal influences"*. [22]

If one team of researchers find the possibility to transform advanced or complex multidisciplinarity (A&CM) into holism or holistic approach, this difficult action will generate a great number of key advantages, coming from a new way of understanding why people do the things they do and think the way they think:

1) holism or holistic approach as the limit of A&CM proposes that it is necessary to look at the entire person;
2) holism or holistic approach as the limit of A&CM renounce to focus on just one aspect of the reality, understanding that is necessary indeed to recognize that different and expected factors interact and influence permanently each other;
3) emergent properties underline the profile of the parts inside the whole reality (population), but cannot be observed by looking only at the individual pieces (individuals);
4) beyond the parts, segments or variables from the reality even the factors in the holistic approach as the limit of A&CM model interact and influence one another;
5) holism or holistic approach as the limit of A&CM remains a bit more focused;
6) holism or holistic approach as the limit of A&CM allows researchers to assess multiple factors that might contribute to a difficult change in the entire reality (rather than simply focusing on one small part of an issue, researchers can instead look at all of the elements that may play a role based on holism or holistic approach as the limit of A&CM), etc.

Just like the reductionist approach to Psychology or Sociology, holism or holistic approach as the limit of A&CM has both advantages and disadvantages. [22]. Holism or holistic approach as the limit of A&CM can be helpful at times when trying to understand the big picture allows the researchers to see things they might have otherwise missed, or in other cases, however, focusing on the whole reality might cause them to overlook some of the finer details.

In the case of any multidisciplinary research of a really *big* project, where *big* means the maximum number of disciplines implied in the investigation, reductionism will still exist and tends to focus solely on the trees, but holism or holistic approach as the limit of A&CM allow researchers to view the entire forest. This can be the final truth of both the research results of the two different ways of thinking and research.

There are also some important disadvantages of holism or holistic approach as the limit of A&CM to consider. In pragmatic problems, it is often important to focus on a particular aspect of the issue to come up with a more adequate precision and a prompter solution. Holism or holistic approach as the limit of A&CM tends to be the most generalized variant of research, which can sometimes make precision more difficult. Any team of researchers must be able to focus all of their activities on very well defined variables, parameters and hypotheses, tests and methods of validation etc.

As a final remarque holism or holistic approach as the limit of A&CM really incorporates many variables, offering the image of the big picture (reality) or the opportunity to view the entire forest, but in a lot of investigations holism or holistic approach as the limit of A&CM tends to be non-specific or non-adequate or it can be even overly complex being too much opened or too all-inclusive.

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