Knowledge – Science – Math Under the IT Rule and the Rise of the *Fourth World*

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Abstract The tradition of the last few centuries allows mathematicians to reveal purely formal meanings, science to add to them meanings acquired through experiment formally supported by mathematics, and to them knowledge adds purely experimentally accessed meanings. Information technology, IT, manages, in the last few decades, to change the hierarchical balance established between sense, significance and syntax in the trio formed by knowledge, science and mathematics. By relating to IT, the relationships between the latter change, primarily because their nature is strongly influenced by the new actor on the scene of the interaction of the human mind with existence. The relationship with IT of each form of access to the meanings of existence becomes dominant, and the interaction between these forms is increasingly intensified through information media. The central and mediating position that TI acquires induces more complex and nuanced relationships in the knowledge - science - mathematics trio, which will hopefully allow access to a wider range of meanings. In the IT-dominated context, we highlight the emergence of a fourth world of unstructured and/or unreliable information.

Keywords: information technologies, meanings, sense, signification, the fourth world.

Introduction

Understanding is a mental behavior organized hierarchically on the following three main levels:

- mathematics, which provide rigorously organized formal meanings related to forms imagined or suggested by the real world
- science, adds meanings acquired from organized experiments formally supported by the mathematical approach
- knowledge, completes the mental image of existence by purely experiential facts when the phenomenal behavior can not be reduced to forms.

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In the XVII-th century starts the process of disenchantment by imposing the previous hierarchy which starts with the simplest representations provided by the mathematical approach and ends in the non-formal phenomenological realm of representations. Knowledge includes science, and, in turn, scientific knowledge includes the mathematic understanding. It is about inclusion, not subordination.

Pre-informational age

In the transition period of Baroque (1600-1750), Francis Bacon (1561-1626) and René Descartes (1596-1650) started to struggle to overcome the tradition coming from Plato and Aristotle but also from the humanistic tradition of Renaissance. The ancient tradition was scientifically obsolete, while the Renaissance humanistic heritage was full of mystic, magic, hermetic, cabalistic, alchemic influences. The experimental approach (Tycho Brahe (1546-1601), Galileo Galilei (1564-1642), Johannes Kepler (1571-1630)) and the mathematical support it used (René Descartes, Blaise Pascal (1623-1662), Isaac Newton (1643-1727), Gottfried Wilhelm von Leibniz (1646-1716)) shaped the transition to the modern understanding of existence in the pre-informational age.

It is common to talk about science based on math or scientific knowledge, but very rarely about mathematical knowledge, because the interdependencies between the three levels of understanding are predominantly "linear", in the sense that the connections between mathematics and science and science and knowledge were strong, while between mathematics and knowledge they were week (see Fig. 1). This situation is due to the fact that:

mathematics : build abstract systems governed by the syntactic order of forms partially inspired by the real world and partially due to the creative imagination of mathematicians

science : reveals forms in the real world by reducing real phenomena to rigorously manageable forms using mathematics as a supportive tool

knowledge : appropriates additional useful meanings as evocative senses considering real phenomena, where the scientific reduction mathematically supported doesnț work

while the connection between mathematics and deep phenomenological knowledge was somehow compromised by the numerological "techniques" practiced during the Middle Ages.

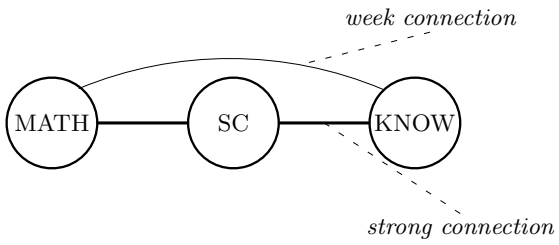

Figure 1: How are connected in the pre-informational age mathematics, science and knowledge.

The period of Enlightenment, besides the liberty without responsibility and profane without sacred, promoted a pure rational approach based almost exclusively on quantity[2]. The relation between mathematics and sciences strengthens, with a very positive effects on the development of sciences, but the knowledge starts to be limited to the scientific approach. The simple[3] and purely quantitative[4] approach is exclusively imposed. The evolution was so spectacular that, towards the end of the 19th century, there were voices that considered necessary to be specified only few details in order to complete the process of knowledge in our universe. But, in a short time, this optimistic mood was disturbed by unpredictable developments: some coming from new openings in the Western world and some coming from the Eastern space.

New openings in the Western type of understanding

The end of the nineteenth century and the beginning of the twentieth century come with fundamental reconsiderations of the basic elements of knowledge. David Hilbert (1862-1943), Max Planck (1858-1947) Albert Einstein (1879-1955) and Sigmund Freud (1856-1939) in the middle of this period, around 1900, challenged the scientific community with new openings, openings that the twentieth century has not yet managed to completely exhaust.

Mathematical decision

2500 years after the Cretan Epimenides provoked Western rationality with his famous undecidable sentence, David Hilbert's communication at the Congress of Mathematicians in Paris in 1900 paved the way for a solution through reformulations that will be clarified by rigorously defining the problem of decision [13]. In 1928, Hilbert finally formulated the *decision problem* (*Entscheidungsproblem* as it is known in German) in a book published with Ackermann [14]. As a consequence, in 1931 the logician Kurt Gödel (1906-1978) formulated the most important negative result in the history of mathematics in the form of his incompleteness theorem [10].

Gödel's fundamental work triggers the emergence of information technologies. Five years later, four mathematicians, Alonzo Church (1903-1995) [3], Stephen Kleene (1909-1994) [15], Emil Post (1897-1954) [18], Alan Turing (1912-1954) [20], they published their works starting the computing era.

Quantum & relativistic mechanics

When in the second half of the 19th century it was considered that there were only a few aspects of detail that needed to be clarified in physics, the scientific world is set in motion by two fundamental reconsiderations related to *continuity* and *absolute*. Quantum and relativistic mechanics force the scientific community, through the seminal works of Max Planck [16] and Albert Einstein [7, 8], to restart the engines of the process of knowledge at unprecedented speeds.

The models proposed by physicists used the continuity hypothesis and absolute reference systems. Planck and Einstein force the rethinking of physical processes in a discontinuous context and based on relative references. If formal/mathematical and

[2]How well Wolfgang Amadeus Mozart and Lorenzo da Ponte caught this effect in their *Don Giovanni*! See by turn *Viva la liberta*, *O statua gentilissima*, and *Madamina* from Mozart's *Don Giovanni* opera [19].

[3]Carrel's, *Man, The Unknown* [1]

[4]Eventually, maybe too late, René Guénon in his 1945 book [12] warned those willing to listen about the destructive effect of the pure quantitative approach.

experimental support strongly supported these new approaches, direct perception was shocked. Feynman's famous sentence *"Shut up and calculate"* is one of the consequences of the quantum-relativistic revolution. Thus a closer connection than ever was made between mathematics and science.

Unconscious mind

In 1900 Sigmund Freud published his most important work: *The Interpretation of Dreams* [9]. Man ceases to be fundamentally and exclusively a conscious being, who can share with others his entire mental experience. The revelation of the beyond of consciousness in the human mind has opened new avenues for understanding what man and existence might be. The multiplicity of states of consciousness, as an experimental fact, provided the context of much enriched approaches to man's relationship with existence.

These three events, produced in completely distinct fields – mathematics, physics and psychology – will have consequences that will converge, in the second half of the twentieth century, towards fundamental reconsiderations, in the process of assimilation and integral capitalization for knowledge. This is the reason why the process of knowledge coexists today, perfectly justified, with a parallel process of philosophical interpretation. The philosophical approach is mandatory because the historical "moment" seems to be an integrative one, in which its knowledge and interpretation are accommodated in a relationship of causal synchronicity.

The influence of the East on Western thought

The first notorious Buddhist in Western culture was Arthur Schopenhauer (1788-1860). He had a statue of Buddha on his desk. One of the important ideas in Buddhism is that the world is an illusion, which leads to distorted representations that we can form on realities. The rationalism of the Enlightenment is thus called into question by considering additional forms of knowledge made from a subjective perspective.

But only in the second half of the 19th century did the West pay more attention to Eastern spirituality, considering it primarily from an exotic perspective. Thus, in the second half of the nineteenth century, Eastern ways of understanding began to provoke some Western minds with two main results.

A first effect of the Orient was manifested by the esotericisms induced by the theosophical movement of Helena Petrovna Blavatsky (1831-1891), extended in the anthroposophical movement of Rudolf Steiner (1861-1925), to name only the least irrational currents.

A second effect was that of reconsidering various Western esotericisms. Personalities such as Eliphas Lévi (1810–1875) and Papus (1865–1916) triggered currents that were continued by René Guénon (1886–1951), Julius Evola (1898–1974) and Frithjof Schuon (1907–1998). It is very difficult to position Carl Gustav Jung (1875-1961) in this context through his essential contributions, following the approach started by Freud, through which he realizes a well-founded bridge between Eastern and Western thought.

Relaunching the Western project

The reactions and counter-reactions that appear in the confrontation between East and West, between subjective and objective, between imaginary and rational, give a specific color to the first half of the 20th century.

One of the most significant reactions is the formation of the Vienna Circle of Logical Empiricism, a group of philosophers and scientists in the fields of natural sciences, social sciences, logic and mathematics, which met regularly between 1924 and 1936 at the University of Vienna, under the leadership of Moritz Schlick (1882-1936). The major influence of the concerns of this group was manifested in the field of analytical philosophy and philosophy of science. The main contributions were of some participants, in a way marginal to the activity of the circle: Ludwig Wittgenstein (1889 -1951) [22, 23] and Kurt Gödel [10].

We can also exemplify the diversification of interpretive currents by the Copenhagen Interpretation which is an expression of the meanings of quantum mechanics that was largely conceived from 1925 to 1927 by Niels Bohr (1885 -1962) and his close collaborator Werner Heisenberg (1901- 1976) and which remains one of the most accepted interpretations of quantum mechanics.

We cannot neglect the effect that World War II had through a new and surprising synthesis between mathematics and its implications in the emergence of computer science and technology.

We can highlight the three significant processes that took place in this period of transition to an era in which information will begin to dominate the relationship we are discussing between knowledge, science and mathematics.

Quantum mechanics and the fullness of existence

The internal and external coherence of the formalism of quantum mechanics has always been doubled by the most controversial interpretations. Among them, the imposition of the non-locality principle is the source of some spectacular speculations. The locality, characteristic of classical physics, allows the structural approach, an approach that is seriously questioned when the non-locality is taken into account.

We have become accustomed to the fact that the form corresponds to the essence. The Platonic tradition, fixed by the Christian mentality, confuses the abstract form with the absolute essence. It seems that it is not a big mistake at the level of classical, conventional understanding. However, it proves to be a serious error when the approach of knowledge approaches the depths of existence.

How can two fundamentally distinct (somewhat contradictory) forms consistently refer to the same essence? How can we model correctly both through particles and waves?

The interpretation given by a classical, structurally truncated mentality, to a plenary reality can only be inconsistent. The interpretive, philosophical framework must be broadened to fit a science in which non-locality is principled and in which the dogma of identity between (abstract) form and (absolute) essence is no longer accepted.

Psychology and trans-personal development

Freud‘s discovery, extended and deepened by Karl Gustav Jung (even against the will of the discoverer of the unconscious), brings psychological thinking to a level from which, starting with syntheses with other fields to be possible and useful.

If Freud discovered the unconscious, it was Jung who revealed its magnitude (too limited by Freud to sexual aspects). Jung was also the one who understood the viable and complementary alternative offered by Oriental thinking for understanding the psychology of the unconscious.

The collective unconscious postulated by Jung provides the strongest basis for understanding the spiritual unity of humanity and ultimately provides a path to the deep connection of the mind with existence in all its fullness.

The most tangible result of this evolution is transpersonal psychology, in which the tradition of spiritual practices in the East and the West is combined with the most advanced achievements of modern psychology. The birth certificate of transpersonal psychology is the founding in 1969 of the journal Transpersonal Psychology by Abraham Maslow (1908-1970) and Antony Sutich (1907-1976).

From here to the AUC (altered state of consciousness), proposed for study by Charles Tart (n. 1936), or the hierarchy of levels of consciousness proposed by Ken Wilber (n. 1949) (sometimes accompanied by an exaggeratedly unjust critique of Jung‘s contribution) was only a step .

The mind as a physical device with a functionality that cannot be completely described formally appears to psychologists coupled with the fullness of existence at various levels of depth. Consequently, the understanding of the mind can no longer be separated from the understanding of existence at all these levels.

Integrative philosophies

More than ever in the modern history of science, researchers have been involved in general, interdisciplinary or philosophical debates. Paradoxically, the better the concordances with the theoretical predictions, or the more obvious the formal rigor of the demonstrations, the more precarious the possibility of interpreting the theoretical options. No one questions Schrödinger‘s equation or Gödel‘s theorem, but most researchers debate the significance of their meaning without being able to fully agree.

Science is progressing, but the conceptual tools for interpreting its progress are proving increasingly powerless. And no one can know if, at some point, the real progress of knowledge will be limited by the precariousness of the tools of integrating science into a unitary vision.

Thus, the concern of researchers for the philosophical integration of knowledge results becomes common. Without considering the activity of "professional" philosophers (such as Edmund Husserl (1859-1938), Alfred North Whitehead (1861-1947), Sri Aurobindo (1872-1950), Karl Popper (1902-1994) or Ludwig Wittgenstein) unimportant, we still comment on major philosophical contributions, "from within", made by researchers with a solid scientific background. We refer in this sense to philosophical contributions that bring to our attention the *implicate order* of David Bohm (1917-1992) [2], the *structural-phenomenology* of Mihai Drăgănescu (1929-2010) [5], or the integration of the *levels of consciousness* proposed by Ken Wilber [21].

The relations between mathematics, science and knowledge will change under the pressure of the evolutions that take place in each of these fields. The firmness of the results based on the rationality of the forms is questioned when the decision on the validity becomes questionable. When the results of scientific experiments become relative and depend on the intentionality of experimenters, the (subjective) interpretation casts shadows on the objectivity of the scientific approach. To all this is added a mind that is perceived as manifesting itself on several levels of understanding, which further complicates the understanding of what mathematics and science are able to offer.

And if all this was not enough to increase the complexity of the relationship between mathematics, science and knowledge, in the second half of the century emerges with exponential intensity science and information technology.

Informational age

It all started with the approach of mathematicians who translated Godel's result from the field of logic to that of mathematics. It was a successful attempt to assess the effect that logical incompleteness can affect mathematical rigor. The effect of the incompleteness of the formal approach was thus rigorously delimited.

Surprisingly, the emergence of a new scientific field with associated technology has resulted. Serendipitous coincidences or implacable causality led Alan Turing to be involved in the world's second conflagration at Government Code and Cypher School at Bletchley Park, or the ENIAC computer to be built for the purpose of calculating artillery-firing tables. It is difficult for us to separate external causalities, such as defense policies, from internal causalities inherent in the developments in the three areas investigated.

A dramatic change happens when a new actor enters the scene. It is about ***information technology*** (IT). By its main functions:

- modeling: allows the description of realities that cannot be (simply) captured through analytical forms.
- simulation: offers solutions where solving systems of differential equations is not analytically possible.
- designing: based on modeling and simulation the design process can efficiently and quickly address topics of an otherwise inconceivable complexity
- interconnection: through communication systems, IoT, and the like, complex connections are made with effects that can be more or less positive
- sensing: involves connecting to the complex reality offered by both the natural environment and the artificial or social
- learning: through artificial intelligence (AI) techniques information systems can learn by detecting subtle patterns that the human mind is not able to identify
- securing: by providing communication systems that allow the transmission of data so encrypted that only the recipient has access to them
- acting: based on the previous characteristics, the computer systems can act autonomously in favor or against the environment in which they were implemented.

IT increases the complexity of our approach and provides another way mathematics, science and knowledge are interconnected (see Figure 2).

In this new context:

mathematics acquires experimental instruments borrowed from science mediated by information technologies (provides approximate solutions for hard problems); thus the term *experimental mathematics* is found more and more in the specialized literature

science acquires new tools allowing the discovering by complex and intense simulation (how proteins fold) or for investigating hidden realities using complex data processing (looking for oil fields)

knowledge by adding subtle knowledge using appropriate learning mechanisms (experimenting on real data using artificial intelligence technologies)

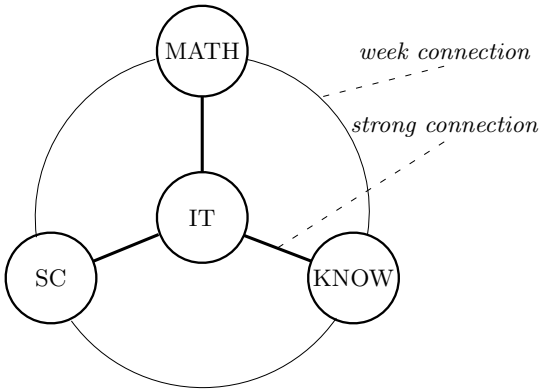

Figure 2: In the information age mathematics, science and knowledge are strongly mediated by information technologies.

so that TI becomes a dominant mediator between the three areas considered.

Scientists are increasingly using mathematical concepts in an IT-mediated way. Indeed, integration through a program (written in MathLab or Mathematica) is increasingly used. We accumulate informal knowledge primarily through computer systems of communication and connection to reality, to the detriment of a direct contact or mediated by the scientific understanding of the phenomena.

In a somewhat paradoxical way, TI ensures a closer connection doubled by a disconnection accentuated by a too "authoritarian" mediation of the IT environment. The balance between these two contradictory tendencies can only be made by the good discernment of IT users.

The relationship between exposure and concealment acquires nuances and possibilities impossible in the pre-informational era. Always, a third world product had to be subjected to a very fine dosage of revelation and wrapping.

The fourth world: an unstructured and unreliable data layer

With the emergence of IT, a clear differentiation is required between the field of information and that of data. More rigorous definitions are needed for these two notions.

Starting from the definition of the information given by Mihai Drăgănescu [6], we will note the difference between information and data.

Definition 0.1 *Information is a structure with an internal syntactic order that has an associated meaning through which it acts in the system in which it is integrated.*

◇

In a computer system the information is represented by the programs that process data. In this sense, the data, represented similarly to the information, are distinguished by the fact that their meaning is not manifested at the level of the computer system.

Definition 0.2 *Data are syntactic structures with a meaning that act, if they do, outside the system in which they are integrated.*

◇

If in the pre-informational age the third world highlighted by Karl Popper has emerged (see Figure 3.a), in the information age we are isolated from the authentic products of the third world by a "thick" unstructured layer that seems to form a fourth world that isolates us from reality (see Figure 3.b). The image of the world is distorted by this new world of signs which acts not by syntactic order, nor by the associated meanings[5], but by messages in which the sense is hidden behind misleading significance.

In this context, a buffer of un-structured and un-reliable data emerged between the real world and the traditional semiotic world. The natural semiotic space is thus isolated from the real world trough the unstructured and unreliable data, or, worse, manipulated data. This intermediate layer belongs unfortunately to the information domain because it acts, rarely for the good, but especially for the evil of the human world.

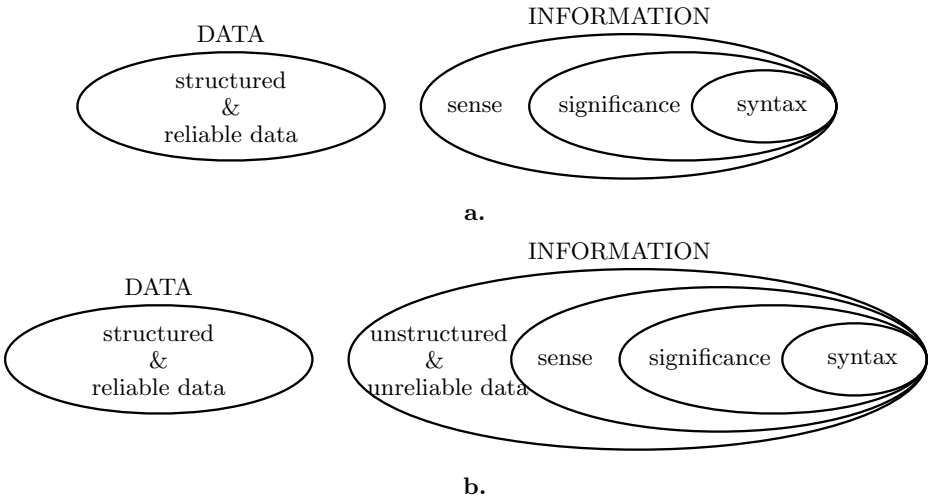

Figure 3: **a.** In the pre-informational age, the Popperian *third world* [17] of structured data is part of our world we access according to our own will. **b.** In the information age, a thick layer of ***unstructured data*** mediates imperatively our access to the world blocking our direct access to the real world.

The new symbolic layer of data wrapped around traditional layers, represented by syntactic order, significance and sense (see Figure 3.b), disrupts the human being's interaction with existence, especially due to the fact that there are no mental protection mechanisms configured in the Darwinian evolutionary process for this new, parasitic entity. Information technologies aggressively "promote" the components of this fourth world in a space where there are no educational processes that protect us against it.

The development of the fourth world tends to fundamentally change the relationships, re-established in the computer age between knowledge, science and mathematics (see Figure 2). IT makes its mark on the relationships it establishes and through the

[5]We consider the meaning under the two aspects through manifestation: significance and sense. Significance (of reference or of context) associates with a formal structure, subject to a syntactic order, a reality to which it refers or considers it in a certain factual context. The sense evokes sending the thought into a complex of meanings through which the univocity of the association is replaced by a more or less extended field of possible meanings.

components of the fourth world, a world of unstructured or non-transparently structured information.

If unstructured information can usually have benign effects, non-transparent structured information can spoil the harmony between knowledge, science and mathematics.

What do we mean by the non-transparent structuring of information from the fourth world? An ordered syntactic structure can associate meanings in a process in which intentionality is manifested explicitly. But since the intentionality that acts in a process of signification is not expounded or is deliberately hidden, then the meaning that emanates is not transparent. It is non-transparent, because it derives from occulted meanings.

Knowledge is the most disadvantaged by the manifestations of the fourth world. Unstructured and/or manipulated information disrupts with maximum effect the ensemble of representations on the world that benefit from the rigor of form or the cervix of the experiment.

It is enough to discuss the proliferation of the transformation of publishing houses into printing houses in spaces where the freedom acquired in the last three decades has also suspended natural restrictions that gave coherence to the third world. The unlimited space for the disposition of expressing opinions and beliefs uncensored by scientific control and formal rigor has led to the proliferation of a space that is grotesque and vicious. Freedom without responsibility gives birth to the monstrous construction of the fourth world.

But the fourth world of unstructured or unreliable information can prove useful if it is subjected to filtering and organizing processes based on advanced IT tools. For example, the hidden significations that lead to dysfunctional senses can be revealed by artificial intelligence (AI) techniques that are able to highlight subtle patterns that escape analysis by traditional methods. But surprisingly, useful content can be extracted from it that is compatible with the third world, which it can substantially enrich.

Mathematical tools that require a particularly intense computing have developed and continue to develop. The use of these computer tools has consequences on the three actors: mathematics, science and knowledge. Mathematics acquires increasingly used experimental components, science has access to reality on demand through traditional methods of research has no access, and knowledge is enriched by methods and knowledge gained informally and/or beyond repeatable experiences.

We will have to learn to expose ourselves to the more or less deterministic chaos of the fourth world. Confronting him, if made from competent and honest positions, can bring substantial gains to man‘s position in his world. It all depends on how the top-down actions are complemented, if any, by the bottom-up actions. Can the IT-based information environment be a space where the inconsistencies between the world of forms, the world of repeatable community experiments or the world of unrepeatable individual experiences can be reconciled? If so, then abstract forms, community and individual practices have a chance to harmonize to form the full man that humanists of all times have dreamed of.

Concluding remarks

The information age brings with it two major events. First, the change in the way the knowing mind manifests itself in the three areas: mathematics, science, knowledge. Secondly, the emergence of what we call the fourth world of unstructured and / or unreliable computer products with both negative and positive effects.

IT is established in a central position mediating dominantly the relationship between mathematics, science and knowledge.

In the space that TI establishes, they allow the appearance of the fourth world, which can also become the source of major dysfunctions or the solution for many of the problems of the human world.

Once again it is proven that the human being externalizes [11] functions that are limited by exercising at the level of the individual mind. The exteriorization is done this time in the IT space. Man‘s limited ability to participate constructively and effectively in the progress of his own world requires this externalization in the IT world with the acceptance of all associated positive and negative effects.

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