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SCIENCE, ART AND REVELATION

OR CHROMATIC THEORY FOR INTERDISCIPLINARY KNOWLEDGE

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After several centuries of science, there is no consensus between scientists and science thinkers as to whether or not there is something that deserves to be called «scientific method» and, if so, whether or not it is unique and universal. So, considering all the science accumulated so far, can we find some common shared idea? To begin with, what does understanding mean in science? We should prove three suppositions: first, that the scientific method exists and is unique. The second, that we can gain a panoramic view of the map of general knowledge by using it. And the third, that it inspires not only the acquisition of new knowledge, but also how to disseminate it, that is, a complete theory for teaching.

Keywords: scientific method, science, knowledge, interdisciplinarity, teaching.

The central aspiration of science is understanding reality. In this statement there are already two fundamental concepts: reality and comprehension. The third, required to relate these to each other, is observation.

THREE FUNDAMENTAL HYPOTHESES

The limits of science are marked by three hypotheses that affect the aforementioned concepts, since they circularly influence each other. Reality is observable, observation is understandable and reality is the objective of understanding.

The first hypothesis is that reality exists and is observable. There can be no science regarding an object or phenomenon about whose existence we have no evidence, be it direct or indirect. For example, there can be no science about the coexistence of Greek gods. Or about things that cannot be observed, even if they are real! Thus, a mystical experience can be real in the sense that it exists at least for the one who experiences it, but we can never do science about it because it is not observable. This principle is inspired by a profound reflection by Erwin Schrödinger (1944).

The second hypothesis is that the observation (of reality) is comprehensible. Understanding an observation is finding the minimum expression for the maximum shared content. Shared among what kind of things? Between the observation of different parts of the same reality or between the observation of different realities. Not every observation can be comprehended. The results of football matches in the last one hundred years (or the winning national lottery numbers in the same period) are observable realities, but we cannot do science with them. They are incomprehensible.

«THE CENTRAL ASPIRATION OF SCIENCE IS UNDERSTANDING REALITY»

And the third one is that the comprehension (of the observation of reality) is falsifiable. Not every understanding is scientific. For it to be so, we need the understanding to be sensitive to the reality it tries to comprehend, that is, it must not be shielded against it. According to Popper's nomenclature (1959), comprehension must be falsifiable; reality must have the right to contradict a proposed interpretation. That is to say, even when a reality exists and is observable, and even when we find an understanding for such an observation, science will not be possible if the understanding turns out to be non-falsifiable. As can be seen, these three hypotheses already establish the limits between what is science and what is not.

THREE FUNDAMENTAL PRINCIPLES

We will applied the label scientific method to every process that respects three principles, corresponding

to the three fundamental hypotheses. The first one is the principle of objectivity. Of all the available ways of observing reality, the scientist chooses the one that least affects the observed, i.e., the one that distorts both the observer and the observed the least. This principle does not require that the value is absolute, it implies the demand for a maximum. There are degrees of objectivity and the principle of objectivity requires the highest possible.

The second is the principle of intelligibility. Of all the available understandings, scientists choose the most intelligible. This principle does not require that the value is absolute either, because intelligibility has degrees, too, and one always tries to choose the highest available.

The third is the dialectical principle. It requires the understanding to be falsifiable, that is, liable to be directly disproved by reality. Therefore, it opens the possibility for paradoxes to emerge between reality and the current understanding. There are two kinds: paradoxes of comprehension, where reality (A) contradicts the current understanding (non-A) and the paradoxes of incompleteness, where reality (A) does not find any understanding (no A or non-A). A non-falsifiable understanding of an observation is never a scientific understanding.

THREE FUNDAMENTAL BENEFITS

Each of the three fundamental principles of the scientific method guarantees a benefit from the knowledge obtained thanks to them. The first is the universality of science. Any form of knowledge that respects the principle of objectivity tends to be doubly universal: vis-a-vis the object and the subject of knowledge. This means that scientific understanding depends as little as possible on who its author is and the particular circumstances of the sample of reality chosen for the understanding. This benefit can be summarised in the following sentence: science is the understanding of reality obtained with as little ideology as possible.

The second is the anticipatability of science. Any form of knowledge that respects the principle of intelligibility obtains the benefit of anticipating uncertainty. In the broad sense of the word, science also anticipates what already happened long ago. It is the case of geology, history, biological evolution, archaeology, palaeontology... (Wagensberg *et al.*, 1996; Solsona and Wagensberg, 2002).

The third principle is the progress of science. Any form of knowledge that respects the dialectical principle is liable to detect a paradox of contradiction or a paradox of incompleteness. The first situation can be summed up in the following way: «If what I see contradicts what I believe, I either change my view or my belief». The second situation can be summed up in two sentences: «If I do not understand what I see, I must look for a new understanding. If, conversely, I do not see what I understand, then I have to look for a new observation.»

The first alternative offers an evolution (I change what I see) and the second a revolution or progress (I change what I believe). The first consolidates the current truth, the second eliminates the validity of a truth. The same applies to the second alternative; I can look for a new observation (evolution) or look for a new understanding (revolution).

The case of the faster-than-light neutrinos allegedly detected at CERN contradicted the theory of relativity and was solved without scientific «revolution», since it was proved that the problem came from a

Irene Yuste

«THERE CANNOT BE SCIENCE ABOUT AN OBJECT OR PHENOMENON ABOUT WHOSE EXISTENCE WE HAVE NO EVIDENCE, BE IT DIRECT OR INDIRECT»

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Not every observation can be comprehended. The results of football matches in the last one hundred years (or the winning national lottery numbers in the same period) are observable realities, but we cannot do science with them. In the picture, different tickets from the National Lottery draw.

Any acquisition of new knowledge consists of three phases: stimulus, conversation and comprehension. One does not comprehend until the conversation is exhausted. In the picture, two researchers exchange opinions on their experiment.

loosely connected wire. The case of Maxwell's electromagnetism contradicted Galileo's relativity, and the «revolution» came with the appearance of Einstein's relativity. The Higgs boson, finally detected at CERN, was an example of «I do not see what I understand» and the discovery strengthened the standard model of particle physics, formulated decades before (Witze, 2012). And the so-called *lightning balls*, mysterious balls of fire that have been seen for millennia (they are even mentioned in the Bible), were finally explained at the beginning of the century (Paiva *et al*., 2007).

THREE FUNDAMENTAL JOYS

The three fundamental principles of the scientific method constitute a triple basis for the acquisition of new scientific knowledge. But, in addition, they provide three good indications of how to transmit that kind of knowledge: that is, a whole pedagogy. Indeed, each principle introduces the possibility of intellectual joy. The dialectical principle offers the opportunity of joy through stimulus. The principle of objectivity offers the possibility of joy through conversation. And the principle of intelligibility offers the possibility of joy through understanding. It is an intellectual joy associated to each of the three phases that forms the process of acquisition of new knowledge. If the adjective *new* refers to any citizen in the planet, then we are talking about the creation of radically new knowledge. It is research. If the adjective *new* refers only to a particular citizen, then we are talking about the transmission of knowledge, about education or the communication of science. It seems both interesting and encouraging to confirm the close connection between the method used to create science and the method used to teach science.

Indeed, it is easy to accept that all acquisition of new knowledge consists of three phases that follow each other. The first is the stimulus phase. Any paradox, whether it is one of contradiction or incompleteness, far from being bad news for the mind, is instead a challenge. The detection of a new paradox is a good opportunity for scientific progress. It is the sign that guides science towards consolidation or revolution. First consequence: paradoxes have very high educational value. A good pedagogy does not avoid or hide paradoxes, it seeks them out! Second consequence: paradoxes occur between two of the fundamental concepts: the mind of the observer and a piece of reality itself. This presents a serious problem with all the modern world educational systems because they represent reality (in classrooms, books, films, simulations, papers...), but very few are reality itself (museums, experiments, trips...). A paradox between two different representations of the same reality does not cause the same emotion and is not as intense as a paradox between reality and one of its representations. We can extract at least one great educational consequence from this: students need to get out of the classroom to be immersed in reality. Museums, for example, are not there to be visited, but to be used. A good suggestion is to devote (why not?) a day each week to go out into reality to hunt stimuli, which will then be used to start the next phase of the cognitive process: triggering some kind of conversation.

«SCIENCE IS THE UNDERSTANDING OF REALITY OBTAINED WITH AS LITTLE IDEOLOGY AS POSSIBLE»

The second phase of the cognitive process is conversation. The concept is far easier to define than it is to perform. Conversing is talking after listening to someone who will listen before talking. In the broader sense of the word, everything in science is conversation. Observing or experimenting reality is conversing with it, reflecting is conversing with oneself, teamwork is conversing with colleagues...

And then we have the third phase: comprehension. One does not comprehend until the conversation is exhausted. The school system is generally one-way, flowing from the teacher to the student, and the students' thirst for participation, asking for clarification, illustration or extension, is often repressed. A good suggestion would be to include a conversation subject each year in which the student would prepare for a public oral presentation and a public debate on the presented ideas. This would honour the exercise and normality of such a basic activity in relation to knowledge as conversation.

THREE FUNDAMENTAL FORMS OF KNOWLEDGE

All the aforesaid gives us a better definition of what science is: any knowledge obtained using the scientific method, that is, any understanding of reality compatible with the principles of objectivity, of intelligibility and with the dialectical principle. However we have the clear intuition that other (non-scientific) forms of knowledge are also possible. If we admit that a knowledge discipline is defined by the method used to create it, then we have to ask ourselves how many different methods are also possible.

The limitations of the scientific method suggest another method to keep understanding might be possible. We will call it the artistic method. And the limitations in this new form of knowledge will suggest of a third form of knowledge. We will call it revealed knowledge. Finally, we will suggest what we may call chromatic theory for knowledge, according to which there is not a fourth method for the production of knowledge, which is to say: any knowledge is, in fact, a combination of science, art and revelation.

ART

When it turns out that the object of knowledge is too complex or invisible to be objectively observed, is scarcely intelligible, or when such poor intelligibility turns out to be shielded against reality, the scientific method enters a crisis and the recommendation to abandon it becomes sensible. In these cases we can try another method based on a single fundamental principle that we can call principle of communicability of unintelligible complexities. According to it, a human mind can transmit an ostensibly infinite complexity to another with a gesture (a work, a piece of reality) that is necessarily finite. From the point of view of the scientific method the possibility seems almost a miraculous. Nonetheless, many declarations of *Homo sapiens* over millennia support it. The only thing this

The Walters Art Museum, Baltimore

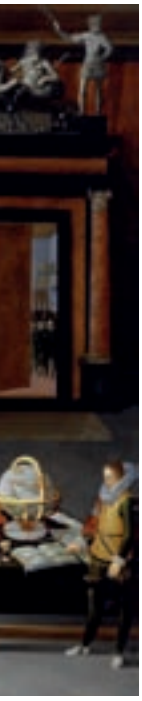
Any form of knowledge is a combination of science, art and revelation. In the picture, *The Archdukes Albert and Isabella Visiting a Collector's Cabinet*, by Jan Brueghel the Elder (1568-1625), where we can see scientific objects and art works.

method requires is sincerity, which, by the way, can only be confirmed in a very particular case: when the emitting and the receiving minds coincide. A declaration of love with a mere glance, the painting of the special light on a landscape or a poem transmit complexities the scientific method would never dare to take on.

However, the artistic method has its limitations as well. Strictly speaking, everyone can be a scientist precisely due to the guarantees of objectivity, intelligibility and dialectics offered by the scientific method. However, not everyone is a creating artist, not even a receiving artist. This – and nothing else – is the limit for the second form of knowledge.

REVEALED KNOWLEDGE

There is a third way of acquiring knowledge that can, in theory, cover what the other two cannot. With the principles of the scientific method in mind, we can argue: Have we reached the limit of objectivity? Let there be an entity for whom everything is objective! Have we reached the limit of intelligibility? Let there be an entity for whom everything is intelligible! Have we reached the limit of dialectics? Let there be an entity for whom dialectics with reality are always



possible! We only need two working hypotheses: the first is that such an entity exists, whether it is a deity or our own conscience. The second hypothesis is that such a revealing entity consents to revealing its truth. Revealed knowledge can contain contradictions and paradoxes. In revealed knowledge, there is the possibility of mystery. However, paradoxes and mysteries are accepted as such. In science, a mystery is always provisional. In revealed knowledge, the mystery is accepted as part of the same knowledge.

An intuition can be defined as a graze between what we understand already and what we still do not understand, between the observed and the yet unobserved... Obviously, an intuition is easily classified as revealed knowledge, but in science it is always a starting point, not the finishing line.

As we can observe, the three forms of knowledge, scientific, artistic and revealed, are, according to their definitions, three limiting principles. A hypothetically pure science would correspond to the application of the scientific method 100 %, without the presence of any art (0 %) or revelation (0 %). Similarly, pure art would result from applying the artistic method 100 %, with 0 % contribution from the other two. Etcetera. It is more than reasonable to claim that there are no pure forms of knowledge, and that any piece of knowledge has something from all three methods.

We take this statement as a working hypothesis and add a second one consisting of the assumption that a pure independent fourth method, different from the others, does not exist. Then we are in a position to advance the whole theory of knowledge.

CHROMATIC THEORY FOR INTERDISCIPLINARY KNOWLEDGE

Both hypotheses can be stated in a single proposition: any form of knowledge is a balanced combination of all three basic forms of knowledge (Wagensberg, 2014).

Let us assume that we want to understand a piece of reality and, in order to do that, we choose the scientific method. No matter how easy it seems, that is, how small the complexity of the reality we intend to understand, the three principles of the method cannot be applied to the full 100 %. The limits to mere observation will prevent absolute objectivity. And the same can be said, for the same reason, about the intelligibility of the observation and its dialectical ability. If the complexity we try to understand through the scientific method is that of a billiard ball, the degree of application of the method will be close to 100 %. Conversely, if the complexity we try to understand through the scientific method is that of passionate love, then the degree of application of the method will be close to 0 %.

In fact, we apply the term science to those understandings achieved with the maximum degree of the scientific method and the minimum of the sum of the other two. Any other combination will be a particular form of knowledge characterised by three degrees represented by three figures from 0 to 100, which together will amount to less than 100. The sum of all three will not be higher than 100 %. If, for instance, we distinguish six hues for each primary colour, then we can characterise 216 different forms of knowledge. We can represent the idea in museography if we allocate each of the Cartesian axes to the primary colours with six possible proportions for each colour. We agree, for instance, that blue is science, green is art and red is revelation. With this metaphor we obtain what we could call a chromatic theory for knowledge. Theoretical physics would be significantly blue, Picasso's work would populate the green and blue planes, Van Gogh's would be more on the green and red planes. We could add to the metaphor the strength of the language used, representing the magnitude by the degree of opacity/transparency. A very mathematical by such as rational mechanics would be almost opaque, while a much less mathematical one like ethology's would be very transparent. An installation such as this one would become a suggestive sculpture at the entrance of a museum devoted to knowledge with a capital K, to universal knowledge, to interdisciplinary knowledge. I do not rule out the idea that the piece will appear soon in the Barcelona Hermitage Museum, which is being designed as a space for the fusion of art and science.

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