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Paradigm and Objectivity in the Sciences: Pedagogical Repercussions from a Wittgensteinian Perspective

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Abstract:

The concept of paradigm became, in the middle of the last century, a central concept in the philosophical discussion about the nature of scientific knowledge. However, little attention has been paid to the strength of this concept in the constitution of the senses in general and, in particular, about its role in the transmission and acquisition of *new* scientific concepts, not only in the community of scientists, but also among basic-science teachers and students. I argue that a Wittgensteinian-inspired reflection on the transcendental use of this concept, as part of the grammar of scientific concepts, can clarify not only fundamental questions about the nature of scientific activity (avoiding both dogmatic and relativistic conceptions), but can also provide us with clues to identify sufficient, though not necessary, conditions so that something becomes an object for scientific thinking in the context of school education.

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> *When we first begin to believe anything, what we believe is not a single proposition, it is a whole system of propositions. (Light dawns gradually over the whole.)* (Wittgenstein, OC § 141)

Introduction

As it is known, after a teaching experience in the 1920s to elementary school children, Ludwig Wittgenstein returned to Cambridge University in 1929, and began to investigate issues that he had left open in the *Tractatus Logico-Philosophicus,*[2] among which, was that of the

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[2] The *Tractatus Logico-Philosophicus* was Wittgenstein's first great work, published in 1921. From now on, I will refer to it only as the *Tractatus*, and I will use the abbreviation Tr when citing it, followed by its aphorism number. As for the other works by Wittgenstein mentioned in this text, I will use the following abbreviations: PI to refer to *Philosophical Investigations*, OC for *On Certainty* and BGM for

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enigmatic nature of the "simple object". Throughout this reflection, he forged a set of concepts such as "language game", "family resemblances", "following rules", "forms of life", among others, with therapeutic purposes in order to clarify the confused thinking and thus dissolving enigmatic problems of traditional philosophy.[3] These concepts and his philosophical observations on the pragmatic functioning of language have impacted several areas of knowledge beyond the *tout court* philosophy, including, more recently, the areas of philosophy of education and science education. In this text, I will resort to the concept of paradigm, as used by Wittgenstein to clarify one of the issues he had left open in the *Tractatus*, in order to describe some of the conditions for a student to constitute new objects of thought in science education, aiming to prevent pedagogical confusions that arise when the teacher disregards the multiplicity of uses of our words, and assumes that *every* word *must* have an extra-linguistic reference, which would be located in the empirical or mental worlds, or even in an ideal realm of metaphysical entities.[4]

As we will see, in contrast to the prevailing image underlying the various philosophical theories that language would only have a descriptive and communicative function, as if there were an immediate relationship between the name and the object represented by that name, our philosopher resorted to the concept of paradigm to obtain the following therapeutic result: "Grammar tells what kind of object anything is. (Theology as grammar.)" (PI § 373). In other words, the meaning we start to attribute to our actions, to what we observe, think and feel, is constituted by *grammar,*[5] which is understood as a set of rules that we learn to follow and that become the condition of meaning for our linguistic expressions and behaviours, within what he would call "language games".[6] These rules, when expressed linguistically, are called by him *grammatical propositions*, i.e., statements that express our most fundamental certainties and convictions, which we do not give up. Wittgensteinian therapy goes through the description of these rules, having as one of its purposes to show, among other therapeutic results, that the *meaning* of a word does not have a previous existence (in the empirical world or in an ideal world), that would be only "dressed" by our language, but is gradually *constituted* by a grammar of uses, inside language games. From this pragmatic perspective, through language, meanings are constructed, and not that they previously existed in the world, as presupposes the referential conception of language.

Mainly in the studies of empirical sciences, the referential use of language manifests itself in a hegemonic way, due to the fact that their primary purpose is to describe the facts of the world, seeking explanations for the phenomena investigated through the observation and experimentation of empirical objects. However, confusion sets in when the philosopher of science and, in particular, the teacher of one of the science disciplines, stuck in an

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Bemerkungen über die Grundlagen der Mathematik, followed by the corresponding paragraph numbers.

[3] Philosophical therapy refers to a method developed by Wittgenstein in the 1930s with the purpose of curing confused philosophical thinking. In this sense, it starts from a problematic concept of philosophy approached by different interlocutors representing different philosophical currents in order to, through a polyphonic dialogue, compare the different positions among themselves, aiming at conceptual clarification.

[4] Cf. Gottschalk (2018, 2020).

[5] Wittgenstein (2009) also refers to the term "grammar" as a descriptive science of the construction of linguistic mechanisms that enable the use of signs, which would characterize the second phase of his philosophical activity: "Grammar does not tell us how language must be constructed in order to fulfil its purpose, in order to have such-and-such an effect on human beings. It only describes, and in no way explains, the use of signs." (PI § 496).

[6] The term, "language game", was coined by Wittgenstein to refer to language as a set of regulated activities, involving not only words but also actions, objects, interlocutors, mental states, among other fragments of the empirical world (PI §§ 7, 23).

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exclusively referential image of language, generalises the descriptive function for the entire scientific language, assuming the existence of autonomous and extra-linguistic meanings previously present, in some way, in the empirical world. Against this assumption, I initiate by presenting the paradigm's role in the constitution of the multiple meanings of a word, and then, turn to other Wittgensteinian concepts to point to some of the implications of that image in science education.

Simple Objects *versus* Paradigms in Language

After returning to Cambridge University in the late 1930s, Wittgenstein began to distance himself from some of his theses in the *Tractatus Logico-Philosophicus*, initiating a process of self-therapy. In this first great work, he had proclaimed that a proposition is meaningful if it corresponds to a possible fact in the world, regardless of whether it actually occurs. Consequently, all the propositions of the sciences would be significant, insofar as they refer to facts of the world that could be verifiable, thus assigning truth values to these propositions (T or F). As we can see, Wittgenstein presents in this first phase of his thought a figurative conception of language, in which language would have as its primary function to represent the world through a projection relation, which, in turn, would occur through thought. Any meaningful proposition of language would be liable to a logical analysis that would result in increasingly simple propositions, in a chain that would end with what he called elementary propositions, namely, statements that did not involve being further analysed into other propositions, they would be constituted only by a set of names. Analogously, each fact of the world represented by a meaningful proposition would also be liable to be analysed in simpler facts, until arriving at facts called, by Wittgenstein, atomic facts, which in turn, would be a combination of simple objects.

At the end of both analyses, each name should refer to a simple object in the world through a substitution relation: each name replaces the simple object represented by it. In other words, language at this last level would play a role in naming. Therefore, in the *Tractatus*, it is at this most elementary level that language would touch the world, as this relation of substitution would be the effective point of contact between language, thought and the world, a condition for the existence of a meaningful proposition.[7] In other words, names would be the "antennae of language" in the world (Tr 2.1515). At this point we can see a referential conception of language guiding the thinking of the young Ludwig, which would be questioned by he himself years later (PI § 23). According to his biographers, at the time he wrote the *Tractatus,* if asked to provide an example of a simple object, he would have replied that this would not be a task for the philosopher, but for scientists.[8] His task would be over by showing how the language was logically related to the world, leaving the door open to investigate how the *application* of logic in the world would effectively take place. However, this atomist way of seeing the functioning of language also left some *philosophical* problems open to our philosopher, as mentioned before, which would be tackled by him many years later, in the early 1930s, already as a professor at Cambridge University, and no longer as a student of his mentor Bertrand Russell. Gradually, Wittgenstein realised that language does perform not only a referential function, but also a multiplicity of other functions. And the contact between the word and the world through the process of naming would be seen by him only as a *preparation* for the linguistic sense.

In fact, in his work *Philosophical Investigations*, already in the second phase of his thought, Wittgenstein begins with an excerpt from Augustine, in which the philosopher of patristics describes learning the mother tongue as being reduced to a naming process: one

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[7] In the *Tractatus*, Wittgenstein states that the simple object cannot be described, but only named (Tr 3.3, 3.221).
[8] See (Monk 1995).

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learns the meaning of words by pointing to their references in the world. In this language image, according to Wittgenstein (PI § 1), "[…] we find the roots of the following idea: Every word has a meaning. This meaning is correlated with the word. It is the object for which the word stands". In contrast to this image of linguistic meaning, our philosopher suggests that we do not make theoretical explanations about the meaning of a word, but that we *look* at how we do *use* it in different circumstances.[9]

Following Wittgenstein's suggestion, if we observe the effective use we make of our words, for example, "ball", "chair" and "table", we will see that it is not enough to point at some objects and say to a child, "This is a ball", "That is a chair", "This is a table", and so on, so that she or he immediately grasps their respective meanings, and believe that next they will be able to compose these simpler propositions into more complex ones, and to say with meaning, "I threw the ball on the table and then it fell on the chair", among others uttered with these words. If we *look*, as a child actually learns to speak, we will see that the same word is used by his or her interlocutors with different senses in different circumstances. The child will be introduced to different balls, tables and chairs throughout his first years of life, and will gradually learn to use these words in certain contexts, until, from a certain unpredictable moment, he or she will be able to apply these words in new situations.

For example, the child who is learning the mother tongue will hear orders from his family, "sit at the table", in the sense of going to dinner, "bring a chair", in the sense of moving it from one place to another, "put away your ball" ("and do not throw it against the window"), among other possible instructions. Pointing at a ball and saying "this is a ball" is not enough for its meaning to be acquired, as the referential conception of language suggests. The ostensive gesture of pointing at an object only has the function of *preparing* the place of application of the word "ball", that is, what is being done is to present a *model* of what it means to be a ball, a *sample* of how we apply this word in certain situations. In short, the presented ball has a paradigmatic function, in the sense that the ostensive gesture introduces that empirical element *in* language, as a *sample* of what it is to be a ball – and not, as the referential conception of language assumes, that we would be pointing at something *outside* language, which would be the meaning of the pronounced name. At this level, it is not yet possible to talk about meaning. The child is initially only being trained to associate the same *word* with similar objects (different balls), and learns to memorise this sound, "ball". Concomitantly, the child will hear this sound in different situations where this word is *used*, until she or he is able to form the *concept* of ball.

Let us take a closer look at what Wittgenstein calls our attention to, when he criticises the Augustinian image of meaning, still using the example above. The moment an adult says to the child, "This is a ball", and points to a ball, this object becomes a means of presenting the language for the gradual constitution of the meaning of the word "ball". In other words, the empirical object ball becomes an instrument of language, is incorporated by it, and is no longer an extra-linguistic object. In this sense, the later Wittgenstein moves away radically from a referential conception of language. The ball pointed at has no meaning yet. At this first level, the empirical object "ball" becomes a *rule* of how we apply this word, among many others, having *in this context* a paradigmatic role: the empirical sound of the word "ball" is connected with the object ball through an ostensive gesture, being established, in this way, an *internal* relationship between the word "ball" and the object pointed at, as opposed to what Wittgenstein considers an *external* relationship between different elements, such as the empirical laws of physics, which establish relations of cause and effect. Interestingly, we have here a situation analogous to that of the simple object of the *Tractatus*, which can only be named. However, from Wittgenstein's new pragmatic perspective, the object employed

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[9] "[..] don't think, but look!" (PI § 66)

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as a sample is no longer a metaphysical entity (like the *simple object* in that work), but *a means of presenting language,* in which the object plays the role of a *paradigm.*[10]

A classic example of paradigm is the standard metre. Until the middle of the last century (from 1889 to 1960), a platinum-iridium bar was considered as the metre prototype, kept under lock and key at the International Agency for Weights and Measures. For being at that time the paradigm of a meter, the platinum bar did not measure a metre, it *showed* what a metre is. Today, it refers to the length of the path taken by light in a vacuum over a time span of 1/299 792 458 seconds. Similar to that bar, the current definition of metre does not have a descriptive role, maintaining the paradigmatic and normative function of the platinum bar: having a metre is the distance travelled by light in a vacuum over a given time interval. Hence, analogously to the platinum-iridium bar, this definition started to play the role of a norm, having a formal use, detaching itself from the empirical circumstances that led to its formulation. In other words, the above definition acquired autonomy in relation to the empirical. It is not a *description* of a metre, but a *rule* we learn to follow in order to apply this word in measuring empirical objects. Thus, we have been using the word "metre" following one or more rules that constitute its grammar, where the current definition of a standard metre is expressed through a definition, and no longer through a paradigmatic object, but preserving the paradigmatic function of its previous application.

It is through the employment of the concept of paradigm (in the sense above), that Wittgenstein clarifies the enigmatic nature of the *simple object* in the *Tractatus*. Something can in fact be considered simple and unyielding to any analysis, *insofar as it has been incorporated into our language,* and not because there are simple elements in themselves, autonomous and independent of language, as initially assumed by him. According to Moreno:

> This [objects unyielding to any analysis] is simply the case for *all* objects that are introduced in our language games as a standard measure, as a *rule* for using words. When taking an object as being the rule for using the word "metre", for example, we cannot say that such an object is or is not "one metre" long, or rather, we cannot measure it, as it is the very criterion of all measurement. But this only means that such an object is taken as an instrument of our language – as a means [of presentation] for our language game – as well as a rule in the game of chess. This object can, in fact, be considered simple and unyielding to any analysis; but only and exclusively because it *became part* of our language. (Moreno 2000, 78)

As observed above, the paradigm performs the role of rule, analogous to the rules of chess. Also in the game of chess, we have rules that say the names of the pieces and how to move them on the board, regardless of their empirical properties. But at this first level of learning the rules of chess, the game is not yet being played, these are just preparatory rules.

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[10] The term "paradigm" is a vague concept, the first meanings of which can be found among the Greeks and which has unfolded into a range of meanings, mainly in the field of empirical sciences.[10] We do not intend, here, to go back to the history of this concept, of how it was introduced by Ludwik Fleck[10] (2010) to shed light on the genesis of scientific facts, and later used by Thomas Kuhn (1995) to defend the existence of incommensurable theories in scientific activity, nor the appropriations made by Paul Feyerabend (2007) in his controversial work *Against method*. Nor is it of interest, for the current purposes, to describe how this concept has been used in other senses and terminologies in different fields of knowledge, such as the *total social facts* in Geertz's anthropology, the *evidential paradigm* in the Ginzburg microhistory, *serendipity* in Merton's sociology or even when the linguistic Peirce introduces the term *abduction* in his semiotic theories (Azanha 1992, chapter 6). Although there is no exact meaning for paradigm, I will consider, in this text, one of its aspects, the one that is more recurrent throughout the history of philosophical thought: that of a norm, a reference for organizing the world in a certain way.

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It is in this same sense that not only the standard metre, but also the ball pointed at, play the role of a rule, one of the rules of the language games in which the child is being inserted, having, therefore, a transcendental use in the Kantian sense, as we will see next.

On a second level (of the game itself), the child will learn to apply the same word (ball) with other senses (following other rules), no longer to name a particular object, but to operate with it in different ways: "Pass the ball!", "Look at the colour of that ball...", "The sun looks like a shiny ball", and gradually, the meaning of this word is constituted, based on the different rules of usage that we learn to follow. Similarly, when a child enters school, she or he will hear new words, which they do not yet know; words that are not present in their daily life, such as "ball", "chair", "table". Now as a student the child will hear about "electrons", "solar energy", "river systems", "cells" and so on. Here again, the question of the paradigm is posed in another context of use. How will the meaning of these words be constituted in the context of school? What will be the paradigms of electron, system, cell, energy, etc.?

Grammatical Propositions as also Having a Paradigmatic Function

Since the writings of Immanuel Kant (1724-1804), philosophers have sought to unravel the enigma of the existence of statements characterised by him as being synthetic *a priori* knowledge, present not only in the field of logic and mathematics, but also in the empirical sciences, although these are mostly made up of synthetic *a posteriori* judgments.[11] In fact, scientific knowledge comes from empirical experience, observations and experiments, thus providing *a posteriori* knowledge. The concept of gravity, for example, was formulated by Sir Isaac Newton when observing the movement of bodies in free fall, in which the empirical experience was a *sine qua non* condition to validate that new theoretical knowledge. *But how does one explain the possibility of new knowledge that does not depend on observation and / or empirical experimentation?* Where does the knowledge come from, for example, that an object falling from one point to another will cover the shortest distance between the two points? There is no experiment that can falsify this claim, that the shortest distance between two points belonging to the same plane is a straight line. It is a type of knowledge that contains a need; we cannot imagine the opposite of this. But where does the evidence for this knowledge come from, which does not depend on any empirical experience?

Wittgenstein's answer to these questions is analogous to that of Columbus's egg; extremely simple and at the same time revolutionary. According to Moreno (2018), our philosopher makes a pragmatic interpretation of Kant's *a priori*, maintaining the idea of a transcendental function of the synthetic *a priori* statements, and attributing the same function to *grammatical propositions*,[12] namely, those propositions mentioned above, that express our most fundamental certainties and that play the role of rules inside our language games. In other words, Kant's synthetic *a priori* judgments came to be interpreted by Wittgenstein what he came to call grammatical propositions. For example, the statement that between two points, the shortest distance is a straight line, seen by Kant as a synthetic proposition *a priori*, comes to be seen by Wittgenstein as part of the *grammar* of Euclidean language games, which underlie Newtonian theories. It is a *condition of meaning* for empirical descriptions in Euclidean space. It is a grammatical proposition insofar as it has a normative function, i.e., we cannot imagine the opposite of what is being stated, that the shortest

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[11] In his work *Critique of pure reason*, already in the title of item V of his introduction, Kant affirms: "In all the theoretical sciences of reason are contained, as principles, synthetic judgments *a priori*" (Kant 1999, 60). My translation.

[12] These linguistic rules, called by Wittgenstein grammatical propositions, are a condition of meaning for the other propositions, constituting a grammar within us, as we will see below.

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distance between two points is not a straight line! This Euclidean postulate plays the role of a rule that entails a need: it must be so.

According to Kant (1999) in his *Critique of Pure Reason*, normative principles would already be present in all theoretical sciences, but, in the case of mathematics, all of it would be constituted by synthetic judgements. In his own words: "they are always *a priori* and not empirical judgements because they bring with them a need that cannot be taken away from experience" (Kant 1999, 60). When adding the numbers "7 + 5 = 12", for example, 12 is not contained in any way in the previous numbers, as it would be in the case of analytical propositions[13], nor is it knowledge that arises from experience. How, then, to explain the evidence of this statement? Kant resorted to intuition in order to overcome this difficulty: "The arithmetic proposition is, therefore, always synthetic; this is recognised much more clearly when slightly larger numbers are considered, since then it becomes evident that, even if we turn our concepts inside out however we want, without getting help from intuition, we could never find the sum by the simple dismemberment of our concepts" (Kant 1999, 61).

Wittgenstein recognises the necessary character of mathematical statements, but differently from Kant, he does not attribute an intuition to the individual as a condition for the recognition of mathematical or geometric evidence. In his *Observations on the Foundations of Mathematics*, he uses examples of how we actually operate with the signs of mathematics, without creating theories, just describing the techniques underlying certain statements. Returning to the example provided above by Kant, from the perspective of Wittgenstein, the statement "7 + 5 = 12" contains a necessity simply because it is based on conventions that we have learned to accept. We group the numerical elements in a certain way, and master a certain counting technique. Most of the time, these actions are learned in the school context, where the teacher presents the child with different techniques on how to operate with mathematical signs. Let us take a closer look at how this happens.

We can imagine that a teacher draws 7 Xs on the blackboard and 5 more Xs beside them, then tells the students that she or he will perform the sum of these elements. The teacher then writes a plus sign between the groups, draws circles around each group, proposes to count all the Xs thus grouped, then places an equal sign next to the two sets and writes beside it the number 12. However, in order to highlight the conventional nature of the rules of mathematics, Wittgenstein encourages us to imagine other possibilities of relating sets of elements, mobilising our will to accept other actions for an arithmetic sum, if the grouping techniques, for example, were different:

"Just look at the figure
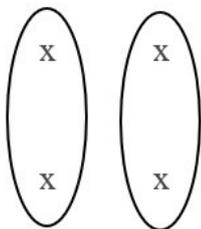
to see that 2 + 2 = 4" – Then just look at the figure

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[13] The analytical propositions are a third kind of knowledge considered by Kant. It occurs when the predicate of the sentence is already present in the subject, as for example, "The rose is a flower". The predicative being a flower is contained (concealed) in the subject rose. See Kant (1999, p.58)

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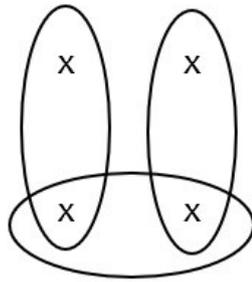
to see that 2 + 2 + 2 = 4. (BGM, I 38)

Although we can imagine people who do this to group objects in their form of life, this way of adding things would not make sense in *our* form of life; this is not how we proceed, this is not how we *act* when we add numbers. We accept the learned conventions without contesting them, they are often as if "swallowed", as Wittgenstein observes in his last writings:

I am told, for example, that someone climbed this mountain many years ago. Do I always enquire into the reliability of the teller of this story, and whether the mountain did exist years ago? A child learns there are reliable and unreliable informants much later than it learns facts which are told it. It doesn't learn *at all* that that mountain has existed for a long time: that is, the question whether it is so doesn't arise at all. It swallows this consequence down, so to speak, together with *what* it learns. (OC § 143)

When we learn a language game (which presupposes the learning of its rules), we do not doubt our teacher, the doubts and agreement only appear later: "Child learns by believing the adult. Doubt comes *after* belief" (OC § 160). Returning to Wittgenstein's example of the arithmetic sum above, in the same way that we "swallowed" that mountains existed for a long time, we also swallowed a certain way of grouping sets to count the totality of its elements, which is not always explained. Most of the time, it is tacit teaching. However, it is sometimes necessary to make explicit such conventions, which become our certainties. Through them, we learn to act regularly, that is, to regularly do different things in different situations. In other words, we learn the institution of "following rules".

The above examples from Wittgenstein help to clarify the enigmatic Kantian question of synthetic propositions *a priori*: the feeling of evidence is linked to our access to the initial rules of the game in which we are being inserted, such as the introduction of paradigms in language, through a determined teaching, gradually learning that there are adequate and inadequate applications. In this sense, the meaning lies in the *application* of the rule, not in the rule itself. The rule we learn to follow is only a *condition* of signification. In the statement 7+ 5 = 12, we sort of "swallow" the way of grouping the elements in play, we count using the learned decimal system, and we do not question the equivalence between the two sides of the equation. And it is at this moment that the teacher's authority comes into play, as the child does not question the tacit statements and actions of his or her teaching. In the same way that it does not occur to a child to question the existence of mountains when she or he hears about them, neither will they question the way in which their teacher groups the elements of a sum: 7 + 5 *must* be equal to 12. This proposition turns to have a paradigmatic function; it becomes a rule that we learn to follow and that we start to apply in different situations. In other words, it turns to be a grammatical proposition in the Wittgensteinian sense. The student is now unable to imagine its opposite, that 7 + 5 is not equal to 12.

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These linguistic mechanisms of construction of a rule are quite clear in the area of mathematics education, resulting in propositions that play a normative function. Initially, fragments of the empirical world are chosen to operate as paradigms. To teach fractions, for example, the teacher presents continuous fragments of the empirical such as cakes, pies and pizzas to divide in equal parts and present them as examples of fractions of a continuous whole, or else he chooses a discrete whole, such as playing cards, or a number of candies to introduce discrete representations of the concept of fraction, or even teach division techniques and point out the result obtained as also being a fraction, and so on. From these initial conventions of what it means to be a fraction, the student gradually learns to operate with this concept in a multiplicity of situations, establishing relationships among its uses. For example, comparing the fractions to each other (a fraction is greater or less than the others), adding them up, dividing them and thus becoming able to solve problems involving partitions. Thus, after a certain moment, we can say that the student acquired the concept of fraction. She or he will be able to apply it in different situations, even in the face of a new application, not yet presented to them.

In the school context, new paradigms are presented, and other meanings are formed from the same word, meanings that are related to each other through family resemblances (PI §§ 66-67). Adding rational numbers will involve other techniques, but with a certain kinship in relation to those that the student already mastered in order to add natural numbers. The numbers will not only be used for counting objects, but the student will also use them to measure objects whose measurements are not represented by integers. We have invented several different techniques that underlie each of these different rules, with family resemblances among them, and we have learned *how* to apply them in different circumstances.

Hence, taking up once again the example of the arithmetic sum, 7 + 5 = 12, unlike Kant, our philosopher shows us that what is behind the conviction with which we affirm this synthetic proposition *a priori* is the result of *training*, namely, the learning of a diversity of techniques learned in the language games of mathematics, *and not due to a supposed mathematical intuition potentially present in the child*. In other words, the feeling of evidence is linked to our access to the initial rules of the game *through a determined teaching*, and not due to any kind of intuition. According to Wittgenstein: "Disputes do not break out (among mathematicians, say) over the question of whether or not a rule has been followed. People don't come to blows over it, for example. This belongs to the scaffolding from which our language operates (for example, yields descriptions)". (PI § 240) As Wittgenstein draws our attention, all these techniques used in the construction of rules constitute the scaffolding that *yields descriptions*, among other functions of our language. Therefore, any empirical description presupposes this previous work on language, and not some mysterious process in the student's mind, yet to be unravelled, and that would allow immediate access to sense data.

This also applies to teaching in the empirical sciences, particularly when observation does not happen immediately. We can imagine such a situation in an astronomy class. How to teach a student what is a "black hole" in the cosmos? Would it be equivalent to describing a hole we fall into when we are distracted? In the same way that the student had to learn the integers to be able to operate with rational numbers, she or he will also need to have the concept of a hole in the ordinary use of the word in order to be able to make sense of the scientific concept of a black hole.[14] Although we cannot have direct access to them, as we

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[14] "Black holes" are objects in the cosmos, which are indirectly observable through powerful telescopes. They arise from the death of stars, and contrary to what was previously believed, black holes do not dredge energy. By analysing the different spectra of the radiation emitted by them,

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would see a hole in the street, we assume that they exist, and this statement ("there are black holes") is a condition for investigating their properties and behaviours. The statement of their existence is, therefore, a grammatical proposition, analogous to statements about the existence of electrons, atoms, neutrons and other subatomic particles. Students are persuaded of their existence, even though they are told that the nearest black hole is 1,600 light-years from Earth. This is an example of a grammatical movement, which resembles a new way of seeing the ordinary use of the word, quite distant from it, but we can recognise some common aspects:

> You interpret the new conception as the seeing of a new object. You interpret a grammatical movement that you have made as a quasiphysical phenomenon which you are observing. (Remember, for example, the question "Are sense-data the stuff of which the universe is made?")

> But my expression "You have made a 'grammatical' movement" is not unobjectionable. Above all, you have found a new conception. As if you had invented a new way of painting; or, again, a new metre, or a new kind of song. (PI § 401)

However, unlike the grammatical propositions that we "swallow" when we are learning our mother tongue, scientific definitions need to be learned, not discovered, as many pedagogical conceptions of the *new school*[15] suggest. These definitions are similar to the standard metre, which some decades ago was represented by a platinum-iridium bar, and is currently represented by a grammatical proposition, whose paradigmatic function remains, stating what it is to be a metre in a new way. Similarly, the successive definitions of "black hole" also play this role; they are not *describing* anything, on the contrary, they are *conditions of possibility* for possible descriptions, which can be empirically verified, confirming or not the current cosmic theories with some degree of probability.

Therefore, although any statement can also have a descriptive use, a definition has the same transcendental function as Kant's pure principles of reason, like his *structures of sensibility* (time and space), with which we would represent the universal *a priori* conditions under which things themselves become objects of our cognition in general. According to Moreno (2018), from Wittgenstein's perspective, the transcendental function becomes pragmatic, as we pay attention to the conventional and arbitrary nature of our propositions that contain a need, as is the case with definitions:

> [...] even when norms are defined during the use of language, the definitions do not express properties of the application circumstances; they exclusively guide the symbolic action, determining or suggesting a path to follow inside the game. This is done, of course, previous to the application of the norm itself, although a given application of a norm can be the occasion to set a new norm (PI § 83). Thus, the norms of use allow the extra-linguistic experience to be organised independently of its material properties, and, at the same time, they are immersed in the circumstances of

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scientists found that they eject more energy than they absorb, which led them to the conclusion that black holes actually consume their mass.

[15] The new school movement emerged from the ideas of Jean-Jacques Rousseau (1712-1778), in his work *Emilio*, a treatise on education published in 1762 that revolutionized current practices. From Rousseau's perspective, the child is not born with a ready reason, but this is being formed from observation and experimentation with the objects of the world. This assumption, based on an empirical conception of knowledge, gave rise to new pedagogies that, until today, advocate the protagonism of the child who "builds his own knowledge", where the teacher is often seen as a mere mediator.

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that experience through the applications of language that are made to them. Thus, we can say that the norms of use are valid *a priori* and constructed *a part post* and this, to summarise the *Tractarian* image critiques by Wittgenstein, causes the crystalline purity of the *a priori* forms to acquire the conceptual transparency of the norms of use – such as the opacity of white (see ÜF), which is norm and application. (Moreno 2018, 29)

In fact, the example mentioned above about one of the rules we follow to apply the word white, namely, that "white is not transparent (it is opaque)" or that "white is lighter than all other colours", also clarifies the process of building these rules and their subsequent application[16] in the field of the sense data. In the language game of colours, these norms may have originated in the empirical, when comparing the colours among themselves, using different objects as samples of certain colours and observing empirical properties of the compared objects. Gradually the rules are constructed, such as, "There are four primary colours", "White is lighter than all other colours" and so on, regardless of empirical circumstances that could eventually contradict these claims. In our Western grammar of colours, they become principles that are followed normatively, or as Moreno suggests above, although built *a parte post*, they turn to be *a priori* principles, in the sense that they acquire an autonomy towards the empirical. From this new conception of language, in which the paradigm occupies a central position, the enigma of the existence of simple objects in the *Tractatus* is dissolved, clarifying the processes of objectivity in the sciences:

> The concept of paradigm solves the difficulties that Wittgenstein had encountered in clarifying the essentially pre-predicative nature of the immediate data of perception and for its linguistic expression – a legitimately phenomenological problem that would accompany his concerns until the end of his life. At this level of elaboration of meaning, rules for the application of words are at stake, as an elementary technique of linguistic practice; we still have no concepts. These will appear only afterwards, as a result of the different applications of the words, marked directly by the paradigm – the logical names of the *Tractatus* – to the different situations still regulated by the paradigm. The result will be the predication, carried out through this new linguistic instrument that is the concept. Wittgenstein readily realises that the same paradigmatic function can also be exercised by statements, that is, by linguistic instruments that contain concepts. And by statements of a special kind, namely, that say what the object is, giving it properties considered essential or, at least, properties that we would not accept to detach from the object. For example, that white is lighter than black, that sensations are private, that the word "table" has five letters, that the sum of 2 and 2 has 4 as a result, etc., are descriptive of properties that the experience seems to be incapable of distorting, or at least, as Wittgenstein says, the opposite of which we would not be able to imagine. Such statements also exercise the paradigmatic function, no longer at the elementary, pre-predicative phenomenological level, but already at the predicative level: they are paradigms, now, of the very being of objects with all their essential properties, or considered as such. (Moreno 2019, 33-34)

In Wittgensteinian terms, "grammar tells what kind of object anything is" (PI § 373) *in both senses above*, at the elementary level and also at the predicative one. At the first level, the child learns the meaning of the table by applying this word in several situations in which she or he observes family resemblances among the different types of tables that are all called "table". At the second level, conceptual relationships are formed that express properties of

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[16] In giving this example, the author refers to the work of Wittgenstein, *Bemerkungen über die Farben*, in which Wittgenstein makes observations regarding the opacity of white (ÜF § 132, § 183 ff.).

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the objects above, that once crystallised, the child cannot imagine its opposite, that the word table does not have 5 letters, or that 2 and 2 is not equals to 4. The statements "table has 5 letters" and "2 + 2 = 4" become part of the *grammar* of what it means to be respectively table and number 4. We have two examples here of an empirical object (table) and another of an ideal object of mathematics (the number 4), which are gradually constituted through internal relations of meaning, beyond the most elementary technique of ostensive gesture (pointing to some empirical object employed as a sample). These norms gradually constitute the meaning of both empirical and ideal objects, exercising also a paradigmatic function, thus constituting the basis for knowledge production. Still according to Moreno:

> Building rules of meaning (…) means to create and even invent internal relations between objects within the technical contexts that are the language games, from relations of logical inference present in mathematical demonstrations and proofs, to relations between sensible objects, such as that between two colours of lighter or darker shades, or the relations of objects with themselves, such as identity or the number of letters of a word, etc. These are not empirical or causal relations, with which the description of the uses of words is concerned, but meaning relations, created in the linguistic activity that involves a myriad of elements of the situations of dialogue and is at the same time involved in them. (Moreno 2018, 33)

Thus, even the relations of meaning between empirical objects are constituted within the language, and not outside it, being possible to conclude that the scientific meaning relations are also constructed *in* language. In other words, scientific theories establish within themselves what their objects of thought are, the rules that we must follow in order to make sense of them. Most importantly, science language games also tell us what should be considered as an empirical object, that could confirm or not its conjectures. In Wittgensteinian terminology, it is the *grammar* that defines what the object is, *and not something external to the use of words*, including what should be considered an empirical object for a specific scientific theory. Hence, scientific theory, as conceptual apparatus, presents the criteria to delimit what is inside and what is outside its theoretical body, i.e., grammar is autonomous in relation to the empirical, *even* in the language games of the sciences.

The Criticism to the *Received View* and the Pragmatic Conception of Wittgenstein

The idea of the autonomy of grammar in relation to the empirical, present in the reflections of the second phase of Wittgenstein's thought, put into question the positivist theses that goes back to Francis Bacon in the 17th century to the theses defended in particular by the logical positivism of the Vienna Circle theorists (Schlick, Carnap and others). The new conception of objectivity in general that emerges from Wittgenstein's late work challenged the positivist image of science that has crossed the century in new guises, and this has not gone unnoticed by some of the philosophers of science such as Thomas S. Kuhn and Paul Feyerabend, who, based on different arguments, made a strong criticism of the *received view*.[17]

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[17] The *received view* has its roots in the ideas of Francis Bacon, present in his work *Novum Organum* (1620), which prioritized the mastery of a single method and empirical experimentation as central to what he considered to be a legitimate scientific practice. In the past century, several philosophers of science have challenged this positivist conception of science, in particular the image that scientific

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From my point of view, both Kuhn and Feyerabend, when criticising the *received view*, approached the ideas of Wittgenstein, as they realised the fruitfulness of the notions of *paradigm* and of *following rules* for a better understanding of the nature of scientific activity. Kuhn, in using the concept of paradigm to support an incommensurability of scientific theories, led him to what he called scientific revolutions throughout the history of scientific thought. Whereas Feyerabend, categorically denied the idea that carrying out science could be reduced to a mere application of a method (seen as a set of rules to be followed). In fact, the history of science shows us how scientific innovation stems, most of the time, from the transgression of a methodological rule (which we could also associate with a paradigm shift), establishing new theories. However, I also think that we can still advance a lot from Wittgenstein's perspective, when we look at science not as a merely *descriptive* activity of the facts of the world (and that, at times, it introduces new paradigms and even transgresses some of its methodological rules), but essentially as an activity that *constitutes* new objects of thought, thus making it possible to organise the empirical world under different aspects, expanding our way of seeing, and at the same time deepening certain themes, relating them in different ways.

In this sense, I believe that Wittgenstein is closer to Ludwik Fleck (2010), a Polish doctor and microbiologist, who looked at science as an activity organised by the communities of researchers, coining the concept of *thought collectives* as open and "communicable" systems: "(…) the process of knowledge is not the individual process of a theoretical 'consciousness in itself'; it is the result of a social activity, since the respective state of knowledge goes beyond the limits given to an individual" (Fleck 2010, 81). Moreover, according to him, a scientific fact is not reduced to an empirical fact. As with *Gestalt* forms, *seeing as* (a fact) is linked to the different theories/conceptual apparatus that we have. Consequently, the scientific fact is constituted within the theory, it does not exist outside it. Still according to Fleck, both the fact and the theory are subject to changes depending on the stage of the investigation, and the "errors" in communication can lead to new scientific discoveries.

Similarly to Fleck, Wittgenstein notes that sensitive perception itself is already conceptual, and therefore, due to a collective way of seeing. To paraphrase our philosopher (paragraph 373 of the PI mentioned at the beginning[18]), a scientific fact is built inside one or more scientific theories; we *see* from the theoretical frameworks learned ("the scaffolding"). To *see as* becomes possible from a "rival" theory, in which new aspects of the scientific object/fact are observed. What Fleck calls an error in communication that leads to a new scientific discovery, in my view, can be interpreted from the perspective of Wittgenstein as a transition from one sense to another of the same concept, allowing not only the expansion of the concept in question but also its interrelation with other concepts, thus constituting what Wittgenstein called grammatical propositions, seen by him as the foundations of meanings that we attribute to the empirical world. In other words, from the perspective of both thinkers, there is no unidirectional scientific progress, as if we were approaching a final reality (empirical or logical). On the contrary, through various linguistic techniques as the basis of our theories and concepts, we attribute multiple meanings to what we think, do and observe, leading to unpredictable directions, sometimes contrary to those taken initially, forcing scientists to formulate rival theories or even to abandon theories previously accepted as definitive.[19] The repercussion of this in education highlights the importance of the

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activity is linear, progressive, and fundamentally dependent on the ideas of notable individuals in their respective areas of scientific knowledge. See (Azanha 1995, Chapter 1).

[18] "Grammar tells what kind of object anything is. (Theology as grammar.)" (PI § 373).

[19] A beautiful example in the history of physics is the caloric theory that had gained wide acceptance during the eighteenth century, with considerable explanatory power. Although at the end of this

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teacher's relationship with his or her students, as it is the teacher who presents to them these new perspectives on the facts of the world, perspectives that we could call … paradigmatic; not in the sense of incommensurable ways of seeing, but in the Wittgensteinian sense of existing *family resemblances* among all of them, in a greater or lesser degree. This antiessentialist concept forged by him explains, in part, the non-relativism of our philosopher.

In fact, as we saw above, from the pragmatic perspective of Wittgenstein, the meaning we attribute to something, be it the object ball or any other (like the "black hole"), depends on the application of one or more linguistic rules, regardless of its empirical properties, i.e., "the meaning of a word is its *use* in the language" (PI, §43). We trigger at least one rule of meaning when using a certain word in a given context.[20] Words alone are meaningless, have no life, what confers life to them is the *use* (PI, §432). In the language games of the empirical sciences, this is quite clear, as the scientist formulates hypotheses, verifies them by making experiments and observing the facts of nature. Wittgenstein himself gives us some examples of language games in the sciences: "describing an object by its appearance, or by its measurements; constructing an object from a description (a drawing); reporting an event; speculating about the event; forming and testing a hypothesis, presenting the results of an experiment in tables and diagrams" (PI § 23), and so on.

However, as I sought to emphasise throughout this text, although most language games in the empirical sciences are practically all referential (since they involve descriptions that refer to objects in the empirical world), the scientific concepts involved in these games were formed from rules of meaning, established through techniques of a *conventional* nature. For example, so that I can affirm, in the context of Newtonian physics, that the colour blue is a luminous wave with a length that varies from 4,300 to 4,700 angstroms, it is assumed that our interlocutor already knows the grammar of the colours of our form of life. She or he has already been introduced to blue objects as having a paradigmatic function, i.e., our interlocutor was previously introduced to fragments of the empirical world, incorporated by language as a means of presenting the colour blue. These fragments of the empirical (blue objects, colour charts, etc.) stop being empirical when they are instituted as norms, stating what it is to be blue. These turn into conventions with a paradigmatic role, which could be different in other forms of life. We know, from anthropologists and travellers, of communities who organise time and space, as well as colours, in very different ways than in Western civilisation. However, it does not mean that *anything goes*, or that there are no ultimate fundaments for our scientific knowledge.

By showing us how we actually constitute the meanings of our words, through various techniques such as that of the paradigms in language, Wittgenstein shows us that the foundations of knowledge and meaning occupy a place between the transcendental and the empirical. As Moreno notes: "Sharing the same paradigms means assuming the same way of speaking and thinking about the contents of experience, giving them the same meanings within the game, sharing the same conceptual grammar, that is, the same rules that we apply when combining concepts" (Moreno 2019, 39). Therefore, although they originated in the empirical, they contain a need that we do not give up, as in Kant's synthetic *a priori* propositions.

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century it was universally accepted, it was replaced in the following century by a mechanical or kinetic theory of heat, summarily rejecting the materialist theory that preceded it.

[20] Remembering that according to Wittgenstein, the rules contain an intrinsic vagueness, they do not *determine* the action, they only establish a field of possibilities; as in the rules of the tennis game, which delimit what is possible and what is not possible to do, but do not say *what* to do (PI § 68).

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Final Therapeutic Considerations

In these dark times of setbacks in environmental policies and scientific research in various parts of the world, in particular in Brazil, the understanding of the processes of attributing meaning to the facts of the world, characteristic of the sciences, becomes essential to distinguish scientific truths from what we call today "fake news". There is an urgent need to distinguish scientific activity from dogmatic theories defended in a fundamentalist way, such as conspiracy theories, which are increasingly in vogue, characterised by their denialism.[21] Science, on the contrary, does not deny the facts, which have a fundamental role in confirming or not its conjectures. Through observation and empirical experimentation, which must follow scientific procedures and canons, our theories change with time. As Fleck had stated, a scientific fact is built into the theory, so *both* changes. The abandonment of some of the scientific statements and substitution for others simply shows science's anti-dogmatism, insofar as a statement is considered scientific if it can be refuted, there are no absolute truths.[22]

Nevertheless, this does not mean that anything goes, as Kuhn was accused of, nor do Feyerabend's ideas[23] lead to the understanding of scientific activity as a systematic transgression of one or more rules of the scientific method. As we noted above, both philosophers only sought to relativise certain scientific tenets of the *received view* and, for this, they took their arguments to the extreme. From a Wittgensteinian perspective, what we have is a *grammatical* relativism, which is situated between the transcendental and the empirical, that is, it is neither a question of "anything goes", nor the belief in ultimate empirical foundations. Our philosopher simply draws our attention to the fact that, although our paradigms (and as well as our grammatical propositions) have their origin in the empirical world, they turn to be *normative*. They are part of our conceptual framework constituted in our way of life, intrinsically involved in our habits, institutions and ingrained in our Western culture.

Scientific activity also involves an enormous amount of techniques and conventions that make this initial connection between scientific language and the world possible, where one of its most elementary techniques, as we saw, is the use of paradigms followed by paradigmatic definitions. Thus, science *has* fundaments that are, at the same time of a conventional nature, *and* constituted by *norms*. As pointed above, these are not absolute foundations, which could be found in some extra-linguistic realm, as presupposes a referential conception of language that dominated the thought of the young Wittgenstein. In fact, in the second phase of his thinking, the meaning of a word does not have a previous existence in the ideal world of logic, nor in the empirical world, nor in an individual's intuition. On the contrary, the senses of a word result from a work within the language games, and therefore, they are linguistic in nature, relating to each other, through family resemblances. As stated by Wittgenstein in the epigraph of this text: "When we first begin to believe anything, what we believe is not a single proposition, it is a whole system of propositions. (Light dawns gradually over the whole)" (OC § 141).

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[21] The term denialism was used initially to refer to the denial of the Holocaust by some historians in the 1980s. More recently, it has been used in Brazil to deny events of the past, such as slavery, torture during the military dictatorship and, currently, to ignore global warming, the Covid-19 pandemic as well as the scientific protocols recommended for its treatment, such as masks, social distancing and the recently developed vaccines.

[22] This was one of the principles espoused by Karl Popper, and which, in my view, in addition to being a staunch critic of the received view, he emphasized the hypothetical character of any scientific statement. See (Popper 1974).

[23] Feyerabend himself reconsidered, in his last writings, certain statements of his work, which could give rise to total relativism. See (Feyerabend 1996).

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In short, the statement that conventional normative statements are at the base of scientific activity does not lead to total relativism *simply because we cannot untie the scientific concepts from the ordinary senses* that we attribute to our most fundamental ordinary concepts, which "belong to the scaffolding from which our language operates", as Wittgenstein puts it. Both scientific and ordinary aspects of our concepts are related to each other through family resemblances; however distant a "black hole" may be from a simple ball that a child learns to kick.

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