

Socio-cultural influences in the transmission of scientific knowledge and alternative methodologies

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1. Introduction

The paper deals with the problem of introduction, exchange and interaction of science between different cultures. While much attention has been given to the dynamics of scientific creation, relatively less attention has been devoted to the process of confrontation of different approaches to science, such as is the case of the conquest and colonization of what es now Latin America.

We look into the process from the viewpoint of an analysis of the cultural dynamics as seen in the colonial process. We see the un darling power structure manifested through legitimation schemes based on certain forms of authority which combine the magical (hence knowledge, language, values and science), and the technical (hence skills, arts, weapons, production and labor modes, exchange and money), as the very essence of the Western cultural synthesis. Indeed, this synthesis is strongly reflected in the paradigms which permeates both the science and the arts, which we chose as the starting point for setting up a conceptual framework for creativity.

Although too broad a concept to be captured in a definition, creativity is understood in many senses, all converging to producing something that is not routine, that breaks up with what is expected and that brings new dimension to an endeavor. Creativity manifests itself in various forms and it is recognized by what it produces, be a creative piece of poetry or a creative goal in a soccer game, a joke or an ingenious proof of mathematical theorem. All these manifestations presuppose something new and which appropriately fits what is exiting and is legitimated by society rules and conventions. It is basically *action* which result from conscious immersion in a *reality* and getting the unconscious release of some form of energy. The crux is precisely on the intensity this energy relates to existing codes. This is a process yet to be understood. But certainly this relation, breaking up or conforming with codes, brings about the dialectical process of unconscious thinking meshing with conscious thinking, which in turn can be conceptualized as a dialectical process of extending and transgressing limits of the accepted.

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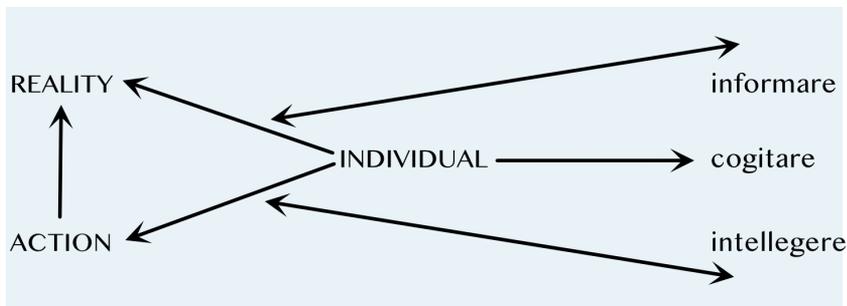
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In regarding creativity, as the dialectical process of extending-transgressing limits, *reflection* upon reality becomes the decisive step towards creative action, which will have input in the same reality which was the deflagrating step. Understanding by reality its full context, we schematize the process as follows:



Borrowing from Ch. Morazé approach to literary creativity. See [Morazé, 1972] for details.

Cultural dynamics, which is embodied in the scheme reality-individual-action-reality, meets then its full dimension. Indeed, like gears, in a mechanism to fit individual actions, be them individual in the proper sense, be them of established cultural patterns, social behavior depends on some thing like engaging properly. Recent work on cultural anthropology indicates forms of behavior which throw some light into the process underlying confrontation of different cultural modes [see D'Ambrosio, 1977]. Recent works on ethno-science and efforts to understand the underlying structure of such manifestations are invaluable elements in understanding this process.

2. Scientific Creativity

Of all manifestation of creativity, scientific creativity deserves a special situation. The controversial issues raised when one asks what is creativity, considering it as the transgression of limits versus the extension of limits, or the socio-cultural versus the individual-psychological origin of creativity, both find in the study of science as a human endeavor, a fertile ground for inquiry. Science played a pioneering role in the revolt against transcendental taboos such as magic, authority, myth and fear of the unknown, by transgressing limits. And yet science is in its very nature cumulative, building up on previous results, whose acceptance carries probably the most hermetic and elaborated legitimation process. See in this respect [D'Ambrosio, 1980] and [Polanyi, 1964]. Indeed, the acceptance criterion which permeates creativity, as discussed elsewhere, is somewhat mysterious in science, or to say the least, relinquished to an organized body of practitioners. Building up on a system of thought which originated in Greece and developed by a complex cultural mesh, modern Western science rises parallel to the overcoming were made by the invaders in many fundamental issues such as religion, style of life and economics and politics, no concessions were allowed in bringing to an universal reach what is called Western rationalism and its most successful realization: Western Sciences and Technology. This renders illusory the first mentioned concessions. But it would be somewhat unbalanced to raise the issue of Western invasions and the overcoming of non-Western civilization, since the process repeats itself in the pattern internally seen

in the so-called modern world, affecting countries, communities, homes and individuals. The image of modern science which prevails is the result of advanced technology and miracle-like achievements, and also from a somewhat vague idea on how did these marvels appear. The body of knowledge and methods, universal and "ideologically neutral", which constitutes Modern Science, reigns undisputed, above the comprehension and calling of society as a whole. We are led again to the issue of the socio-cultural versus the individual-psychological controversy about the nature of creativity. In this case, individual behavior is replaced by the behavior of a minority of individuals identified among themselves by a set of ties common background and interests. More than a controversy, this is indeed a conflict underlying Western civilization, and it is of foremost importance in defining educational and scientific policies, specially in developing countries. Isaac Newton's unmistakable compromise in saying "Scientijs ex uso concialatur gratia" does not differ from current views as expressed, for example, by Nobelist David Baltimore "that society, while it must determine the pace of basic scientific innovation, should not attempt to prescribe its direction" [Baltimore, 1978]. Certainly, considerations of this nature are of fundamental importance for the questioning of the relationship between educational systems and the enhancement of creativity, understood as the manifestation of a significant synthesis of cultural elements. For more on this see [D'Ambrosio, 1977] and [D'Ambrosio, 1979].

We go back to the basic question of what characterizes scientific creativity. In other words, what does make science advance? We way Loog into the creativity folklore and examine the reports of Kekulé, Hadamard, Poincaré and several others to suggest the role of the unconscious in the process of creation in science. For an account of several cases see [Koestler, 1975]. In all these account we find a clearly de fined structure which [Morazé,] puts as informare-cogitare-intellegere, in the sense of getting immersed in a reality, in fact in a global reality which comprises social-cultural as well as natural environment, then reflecting upon this reality and the problem or questioning the challenge therein posed, and finally choosing a course of action in the midst of several possibilities. This coincides basically with the position of Paul Feyerabend in his polemic and stimulating outline of an "anarchistic" theory of knowledge. He claims the "Scientists do not solve problems because they process a magic wand-methodology or o theory of rationality- but because they have studied a problem for a long time, because they know the situation fairly well, because they are not too dumb..., because the excesses of one scientific school ares most always balanced by the excesses for some other school.(Besides, scientists only rarely solve their problems, they make lots of mistake, and many of their solutions are quite useless). Basically, there is hardly any difference between the process that leads to the announcement of a new scientific law and the process proceeding passage of a new law in society: one informs either all citizens of those immediately concerned, one collects 'facts' and prejudices, one discusses the matter, and one finally votes. But while a democracy makes some effort to explain the process to that everyone can understand it, scientifics either conceal it, or bend to make it fit their sectarian interest." [Feyerabend, 1978] p.72. The issue is then placed on the grounds of legitimation of a process, and essentially the accountability that should be implicit in the pact that developed between society and its scientists since the parallel emergence of modern science and technology and of modern society and the concept of public interest

in the seventeenth-century. Significantly, this pacto has been increasingly embraced, up to the point of almost total control, by the stratocracy which grew from the meshing of Morden science and technology with public, social and national interest, back in the seventeenth-century, to unchallengeable power nowadays. The revival of the pact between society and its scientists and the efforts to bring this pact to a new dimension focusing on direct and more immediate social interest, largely depends on the reexamination of the scientific process itself. And of course on the examination of strategies to develop and to facilitate scientific creativity. Surely, those strategies are implicit in educational systems, and we are thus led into looking into educational practices and schooling. But instead of moving into the specific topic of science education, let us allow ourselves some relevant remarks about what might be called the linkage between knowledge and power.

3. Knowledge and power

The relation between these categories of human behavior is implicit in the conflict between the Creator and creature in the Book of Genesis and has permeated Western thought. Indeed, the concept of acquaintance with a body of facts, experiences, signs and codes accumulated by mankind. In this process of accumulation, abstract thought preponderated, paving the way for what is now Western thought. Clearly, this carries implicitly an ideology with profound implications in the social structure of modern world. Of fundamental importance in understanding the prevailing social structure, is the analysis of labor productions patterns and consequently of modes of exchange. The analysis of modes of exchange will bring into consideration the very deep question of how to connect, in the history of ideas, the very concrete, material concept of commodity, with the essentially abstract concept of value. In this connection reside the appearance of money and the origins of monetized society, imprint of Western society, and the distinction between intellectual and manual labor. Indeed there resides the key for the privileged status of knowledge in the overrunning, by Western civilization, of its rivals. The very provoking analysis of the relations between intellectual and manual labor, as a critique of epistemology made by Alfred Sohn-Rethel (1979), suggests the inherency of the search for power in the building up of the preponderancy of knowledge. In more specific examples, this is shown in the overcoming of the concept of wisdom, in traditional African cultures, by the concept of knowledge, as it is very well discussed by Kwasi Wiredu (1980). And also by looking into some of the philosophical grounds on which the conquest and colonialization of America found it is rationale, synthesized in the point of view expressed by the court jurist Juan López de Palacios Rubios in the beginning of sixteenth-century “los infidels debar, como ignorantes que eran, servir a los que sabían, como los súbditos a sus señores. [the unfaithful... should, since they were illiterate, be serfs to those who had knowledge, the same way as the subjects to their owners]” [Zavala, 1977].

This brings us to question what kind of knowledge are we referring to. It is true there is a global knowledge, general and structured in a certain way, following a specific logic, and is in the domain of a certain cultural group, and which we may unequivocally call Western Science. Clearly, all epistemologies currently accepted have been designed to explain this

Western Science. Hence, we face a need for alternative epistemologies if we want to explain alternative forms of knowledge. Although derived from the same natural reality, these knowledge are structured differently.

Our subject lies on the borderline between History of Science and Cultural Anthropology. We may conceptualize *Ethnoscience* as the study of scientific and, by extension, technological phenomena in direct relation to their social, economic and cultural background [D'Ambrosio,]. There has been much research on Ethnoastronomy, Ethnobotany, Ethnochemistry and so on. Not much has been done in Ethnomathematics, but some studies are under way. But Ethnoscience, as a mode of thought, has not been recognized as structured form of knowledge.

Much has been said about the universality of Science. This concept of universality seems to become harder to sustain as recent research, mainly carried on by anthropologists, show evidence of practices which are typically scientific such as observing, counting, ordering, sorting, measuring and weighing, which area carried on a radically way than those which are commonly taught in the schools systems. These remarks have encouraged further studies on the evolution of scientific concepts and mathematical practices in a cultural and anthropological framework. We feel this has been done as yet only to a very limited, and we might even say timid extent. On the other hand, there is a reasonable amount of literature on this subject by anthropologists. To bridge the gap between the research of anthropologists and that of historian of culture and of science and mathematics is an important step toward recognizing different modes of thoughts, which lead to different forms of science, which we have been calling Ethnoscience.

Anton Dimitriu's extensive History of logic [Dimitriu, 1977] briefly describes Indian and Chinese logics merely as background for his general historical study of the logics which originated from Greek thought. We know from other sources that the concept of "number one", is itself a quite different concept in the Nyâya-Vaiśeṣika epistemology: "number one is eternal in eternal substances, whereas two, etc., are always non-eternal" and from this proceeds an Arithmetic [Potter, 1977, p. 119]. Much effort has been given to compare this logic with Western models, and even a preoccupation in showing that the Nyâya concept of number is not contradicted by, for example, the Frege-Russell concept [see J.L. Shaw, 1982]. This is always done taking as reference the Western model and seeing how much other models fit the system. Regretably, practically nothing is known about the logic underlying the Inca treatment of number which, by what is known through the study of the "quipus", represent a mixed qualitative-quantitative language [Ascher, 1981]. And the concept of experience, or the experimental method, is something that may be discussed. When we follow the heavy argumentation of René Thom in favor of an Heraclitian position and his challenge on what might call the "experimental basis of scientific knowledge" in favor of theoretical reflexion, we have to admit the possibility of a new conceptualization for experience.

These remarks invite us to look into the History of Science in a broader context, so to incorporate in it other possible forms of knowledge of natural phenomena. But we go further on these considerations in saying that this is more than a mere academic exercise, since its implications for pedagogy are clear, mainly if we refer to recent advances in cognition, which show how strongly are culture and cognition related. Although for a long time there

have been indications of a close connection between cognitive mechanism and cultural environment, a reductionist tendency, which goes back to Descartes and to a certain extent has grown in parallel with the development of Science, tended to dominate education until recently, implying on culture-free cognition models. A recent holistic recognition of the interpenetration of Biology and cultura opens up a fertile ground of research on culture and scientific cognition.

For effective research action in this field, it is required not only an intense experience in Science, but also investigative and research methods to absorb and understand Ethnoscience. This clearly requires quite difficult anthropological research methods in sciences, a field of study as yet poorly cultivated. Together with Social History of Science, which aims at understanding the mutual influence of socio-cultural, economic and political factors in the development of Science, Anthropological Science, if we may coin a name for this specialty, are topics which we understand as essential research themes not as an academic exercise in itself, as they are drawing interest now in some universities, but as the underlying ground upon which we can understand, in a relevant way, the evolution of scientific knowledge.

History of Science acquires also a more global, clearly holistic, approach, not only by the consideration of methods, objectives and contents of scientific knowledge in solidarity, but mainly by the incorporation of the results of anthropological findings into the 3-dimensional space which we may use to characterize this holistic approach. This is quite different than what has frequently and mistakenly been done, which is to analyze each of these components individually.

This has many implications for research priorities in the History of Science and has obviously a counterpart in the development of Science itself. Clearly, the distinction of Science and Technology has to be interpreted in a different way. What has been labelled Science, or we might emphasize by saying Pure Science, is the natural result of the evolution of the discipline within a social, economical and cultural atmosphere, which can not be disengaged of the main expectations of a certain socio-cultural group in a historical moment. For example, in talking about Mathematics, it can not be disregarded the fact L.Kroenecker ("God created the integers-the rest is the work of men" J.K. Marx), Charles Darwin, were contemporaries. Their theories, what is to say, their approaches to the same reality, represent the expectations of certain sectors of society at that moment. Pure Mathematics, as opposed to Mathematics, came into consideration at about that time, with obvious political and philosophical undertones. This is one of the reason why the distinction of Pure and Applied Science is highly artificial and ideologically dangerous. Clearly, to revise research priorities in such way as to incorporate national developmental priorities to scientific practices, which in the end will generate university research, is a most difficult thing to do. This problem will lead naturally to a close a this paper, touching the relations of Science and Ideology.

Ideology is implicit in dressing, housing, titles and naturally in the forms of thought, including the inherent logic to structured knowledge. Of course, Science results from some logics which underlies the ideological roots of Western civilization.

We have assumed throughout this paper a broad conceptualization of Science, which allows for looking into common practices which are apparently unstructured forms of knowledge.

This results from a concept of culture which is the result of hierarquization of behavior , from individual through social behavior and leading to cultural behavior. This is based on a model of individual behavior based on the ceaseless cycle Hugo aquí van tres punto y las siguiente cuatro palabras una seguida de la otra con un flecha entre ellas (p. 78) ...reality individual action reality... The coptualization of Science which derives from this model allows for the inclusion of what might be considered marginal practices of a scientific nature, and which we have called Ethnoscience. Of course, these common practices are impregnated of ideological overtones which are deeply rooted in the cultural texture of the group of practitioners.

It is the full understanding of these ideological overtones which set the ground for our research program of alternative methodologies.

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