

**THE GLOBALIZATION OF KNOWLEDGE AND THE PLACE OF TRADITIONAL
KNOWLEDGE IN THE GLOBAL COMMUNITY**

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Globalization is often considered either as a promise or as a threat. In any case, it usually refers to the economic processes of the globalization of the markets for goods, capital, and labor, with changes in society, culture, and knowledge being mere secondary consequences. Globalization in this sense is conceived as being governed by market forces and their associated political constellations. Globalization as seen from developing countries appears to unavoidably increase their dependence on forces they can hardly control. Globalization thus seems to be just another step on the road to disempowerment, understandably provoking counter-reactions that emphasize the protection of local interests.

However there is a different perspective that emerges if globalization is conceived in a wider sense and if, in particular, the globalization of knowledge is taken into account as well. Under this premise, new potentials for steering globalization processes become visible that may help to assert local interests and perspectives in global contexts. Here we understand globalization quite generally as the transnational and transcultural diffusion, integration, and transformation of the means of social cohesion, ranging from goods, via language, to belief systems and political institutions. Comprehensive globalization processes result from the superposition of various layers, each with its own dynamics. Remarkably, the globalization of knowledge penetrates all of these layers, influencing them and being in turn shaped by them. Because of this interdependence the globalization of knowledge, rather than being only a side-effect of economic globalization, represents the growing potential of humankind to actively interfere with economic globalization processes in a way that guarantees human survival, counter-acting some of the destructive consequences of these processes. Clearly, using this potential requires, among other conditions, the establishment of an adequate place for traditional knowledge in the global community.

Comprehensive processes of globalization are not only a phenomenon of the present. Our situation today may rather be understood as the result of historical processes that comprise all dimensions characterizing modern globalization processes, each with its own, peculiar constellation of economic, political, technical, cultural, ethic, and epistemic means of cohesion. The study of these historical processes may therefore help to understand the present situation, avoiding the reduction of its complexity to that of a “flat world” (Thomas L. Friedman) and opening up a perspective for regaining autonomy with regard to

the economic constraints by revealing the pivotal role of knowledge, culture, science, and reflection in comprehensive globalization processes.

In the past, phases of intense globalization have always been related to questioning the boundaries of knowledge by cross-cultural, cross-generational and cross-disciplinary encounters. These phases of globalization were often triggered by challenges such as an unstable equilibrium of population density, the scarcity of nutrition resources, a change of ecological conditions, the emergence of new knowledge or new technologies, or shifts in control and regulation mechanisms leading to a transformation of established canons of spatial and epistemic order. The investigation of these past processes may serve to understand the interplay of the various layers of globalization mentioned above.

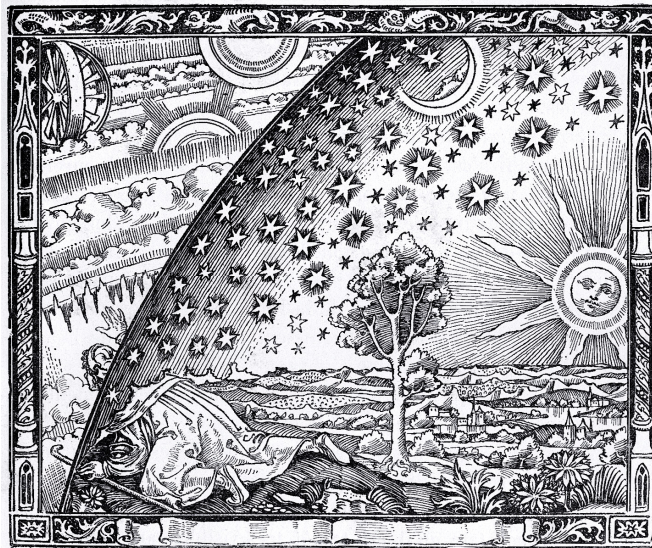
The different relations among the various layers in these processes result from the fact that goods, tools, inventions, suggestions, technical skills and ingenious resolutions circulate among human groups with different speeds of diffusion but typically faster than languages, values, traditional rituals, systems of ideas or religious frameworks, and, in particular, static administrative and political institutions which determine the location of knowledge in the socio-cultural space and its distinct accessibility to the various agents. The differences in speed account for the characteristic retardation of globalization processes after the realization of their initial incentives.

For instance, goods typically arrive before tools, and tools before the capability of making them. The transfer of the knowledge necessary for producing and inventing tools requires in fact linguistic capabilities and frameworks of ideas that can only be built up once globalization processes of other types have taken place. On this background, for instance, the crucial role and the long history of multilingualism beginning with ancient scribal cultures becomes understandable as a critical factor in globalization processes. Multilingualism serves in fact as an indicator of cultural contacts of a certain level of sophistication. Even ancient language cultures saw the necessity of multilingual communication as may be glanced from the very old lexicographical literature, comprising glossaries and other text types which must have constituted tools for making such communication possible and which might be called prerequisites for a further-reaching globalization.

The relation of the different layers is not just one of mechanical succession, or else one could be certain that, for instance, the globalization of markets implies a globalization of the political system – which is clearly not the case. Rather, the interaction among the various layers may lead to very different outcomes of globalization, as may be illustrated by the quite different ways in which religious and political ideas of order are incorporated in Buddhism and in Confucianism, or by the different ways that knowledge constitutes identity and authority in different historical settings, distinguished also by the ways in which ideas gain and lose their authority and the practices with which intellectual authority is maintained. Without taking into account this intricate link between knowledge and identity, it can hardly be understood how globalization may not just act as a leveling process but can give rise to new, emergent features. Indeed, transference in space and time affects the form, status, authority and boundaries of knowledge as well as its meaning. Furthermore, bodies of knowledge in transition are always carried by agents whose identities are constructed in relation to the knowledge they bear from their place of origin,

but also in relation to new kinds of knowledge they encounter in the new space. In the globalization processes of the recent past with their migrations which rapidly diffuse knowledge and behaviors it has become acutely clear that traveling knowledge has the effect of constantly deconstructing familiar boundaries and producing new identities and solidarities. This pattern of globalization processes is familiar at least since the age of colonization and constitutive of the national and cultural identity of post-colonial societies such as Brazil or Mexico.

It may be tempting to conceive globalization processes of knowledge as processes in which local knowledge traditions are either eliminated or absorbed into a homogeneous body of knowledge with universal validity, a body of knowledge that happened to have developed in Europe in two major phases, emerging in classical antiquity and maturing in the Renaissance. On closer inspection, this view is merely a prejudice, which ignores important insights of recent historical studies of science and its contexts. More appropriately, the globalization of knowledge may be seen as the result of an interplay between dominance, resources, and knowledge potentials governing the interchange and transformation of knowledge traditions with their own intrinsic dynamics on a global scale. A particular tradition of local knowledge may accordingly become globalized because of contingent circumstances such as political and economic dominance but also because of its inherent capacities to assimilate other local knowledge traditions. The question of what intrinsic features enable specific knowledge traditions to become globalized in the sense of being capable of assimilating or transforming other knowledge traditions is, however, still widely open.



Globalization does not necessarily mean abandoning traditional knowledge but may well open up new spaces for it. Woodcut from *L'Atmosphère: Météorologie Populaire* (1888) Camille Flammarion: A missionary from the Middle Ages tells how he has found the place where heaven touches the earth.

The history of knowledge is characterized by both the contingencies of the interplay between dominance, resources, and knowledge potentials and the intrinsic dynamics of knowledge development. An analysis of this history requires a typology of knowledge forms, knowledge representation structures, and knowledge transfer processes. *Forms of knowledge* vary along two basic dimensions. On the one hand, they range from universal knowledge, acquired in ontogenesis by every human being, to knowledge that is specific to individuals, social groups, social strata, or geographic regions. On the other hand, forms of knowledge are distinguished by their degree of reflexivity, which is indexed by the distance from concrete objects manipulated in the course of elementary existence. Reflexivity in this sense is lowest in the case of *intuitive knowledge* which is unaccompanied by conscious reflexion and unmediated by symbolic forms; it is highest in the case of *second- or higher-order knowledge*, also called *meta-knowledge*, where the object of knowledge is itself a form of knowledge. This range includes:

- intuitive knowledge
- practitioners' knowledge
- symbolically represented knowledge
- technological knowledge (determined by ends)
- scientific knowledge (determined by means)
- second- and higher-order knowledge

Knowledge representation structures have been studied extensively in the framework of cognitive science and artificial intelligence focusing on the question of how people store and process information in their minds. An analysis of historical processes of knowledge development and diffusion, however, makes it necessary to extend this notion in two dimensions, in order to cover not only internal but also external representations, and not only individual but also shared knowledge. Understanding how knowledge is stored, processed, disseminated through space, and transmitted through history must account for the fact that individual knowledge generally results from the individual appropriation of shared knowledge by reconstructing it from external representations. For this reason, knowledge representation structures relevant to the processing of shared knowledge are characterized primarily by the interaction of the means of external representation available in a given historical situation with individual cognitive structures such as mental models. How do such external representation structures shape the globalization of knowledge and how are they in turn shaped by it? It is, for instance, plausible to assume that the existence of writing systems in South and Meso-America had a significant impact on the encounter of American civilizations with European knowledge, giving rise to new hybrid forms of external representation emerging from this encounter.

The interactional approach requires, on the one hand, taking into account the human cognitive capabilities studied by developmental psychology and cognitive science, ranging from intuitive inferences to the reflective construction of semantic networks. It requires, on the other hand, addressing cultural potentials investigated by behavioral, social, and historical sciences, such as comparative psychology and linguistics, sociology, economics, ethnology, archeology, and history, in particular the history of technology, science, religion, and art.

Finally, *knowledge transfer processes* have to be studied focusing on the relation between the dynamics of invention and development, on the one hand, and the preservation and transmission of established bodies of shared knowledge, on the other hand. All of these processes are determined by diverse media of knowledge transfer, by products, tools and technologies, shared experiences, oral communication, and symbol and information processing systems. Globalization processes such as the geographical dissemination of technologies, the spreading of writing, the cultural exchange between Orient and Occident, the colonization and exploitation of cultures, or the creation of global networks of traffic and communication, involve specific knowledge transfer processes. Examples are the co-transmission of knowledge and technology, the institutionalized transmission of knowledge by schooling, the initiation of knowledge developments by stimulus diffusion, or the reconstruction, adaptation, and accommodation of knowledge by reverse engineering. The understanding of globalization processes requires an analysis of the interaction between such transfer processes and the dynamics of invention and development in order to explain the various forms of globalization such as the convergence of independent achievements, the optimization, differentiation, and adaptation of technologies and ideas, the hybridization of cultural resources, and the role of barriers against knowledge transfer.

The intrinsic dynamics of knowledge development is characterized by the interaction between knowledge forms and representation structures, which triggers processes of reflection that give rise to an ever more complex knowledge architecture. These range from simple mental models of intuitive knowledge to the meta-knowledge embodied in scientific procedures or in normative judgments. Transfer processes depend on the forms of knowledge, on the historically available knowledge representation structures, but are also, of course, subject to the extrinsic dynamics determined by the interplay between knowledge and ecological, cultural, economic, and political factors.

All knowledge traditions are local traditions in the sense of depending, at least at their origin, on specific contexts, specific groups, specific ranges of knowledge, as well as on a specific history determining its architecture in an ultimately contingent way. Globalization of local knowledge traditions involves intrinsic as well as extrinsic developments, potentially enhancing their social dominance, their range of application, and their degree of reflexivity or, alternatively, destroying their autonomy and reducing their complexity. Is, for instance, the globalization of traditional Islamic normative thinking and its decontextualization in this sense an enrichment or an impoverishment of a traditional thinking structure?

The exploration of the consequences of a given system of knowledge in a given social and cultural context and its subsequent restructuration may serve as an example for an intrinsic development, such as, in the European context, the elaboration of the Aristotelian system of knowledge and its subsequent transformation into modern science during the early modern period. The transfer of a given system of knowledge in a process of colonization to a new natural and cultural setting may serve as an example for an extrinsic development. Intrinsic and extrinsic developments may be closely intertwined. The possibility of colonization processes may depend on achievements of intrinsic knowledge developments, such as progress in astronomy or navigation techniques. Extrinsic developments may become the prerequisite for intrinsic achievements, as may be

exemplified by the role of colonization processes for the development of biological knowledge and the emergence of Darwinian biology.

The globalization of local knowledge has to be conceptualized as a cross-over phenomenon, resulting from the integration of local knowledge traditions whose initial encounter depends primarily on a specific constellation of dominance, resources, and knowledge potentials, that is, on an extrinsic dynamics, while their subsequent co-development is also shaped by an intrinsic dynamics.

The globalization of local knowledge is typically accompanied by a localization of globalized knowledge in the sense of the recontextualization of an alleged universal system of knowledge that may trigger its restructuring. Thus, the implementation of European globalized scientific knowledge in non-European contexts will, as a rule, not just take the form of an application and specification, leaving its intrinsic structures unaffected but yield instead a hybridization of globalized and local knowledge, potentially changing the overall history of knowledge even with regard to the initial constellation of dominance, resources, and knowledge potentials.

It seems promising, for instance, to study from this perspective the processes of hybridization between South and Meso-American knowledge, on the one hand, and European knowledge, on the other hand. How are local forms of knowledge integrated into globalized knowledge? Why did the holistic cosmovision of the Maya fail to endure, while much of their traditional survival techniques persisted, with consequences for today's globalized knowledge? How do globalization processes affect in turn traditional survival techniques? Under which circumstances can they improve them, and under which circumstances do they destroy them? What are the mechanisms of localization of global knowledge? Which role, for instance, do local forms of mathematical thinking play for the appropriation of Western mathematics? How do local traditions resist the homogenizing influence of globalization? Are there, for instance, alternatives to seclusive and protective attitudes? Can an active confrontation with the challenges of globalization possibly help to resist its homogenizing effects?

One potential outcome of research along these lines may be the outline of a global genealogy of local knowledge traditions, subject to intrinsic as well as extrinsic developments, and encountering each other in processes of globalization. Such an epistemic genealogy will be characterized by vertical processes of intrinsic development as well as by transversal processes of extrinsically determined integrations of knowledge traditions. It will have to map a multilayered time development in which the internal constitution of a knowledge tradition, ranging from its degree of reflexivity to the media of knowledge representation available to it, is as crucial to the course of history as are local constellations of dominance, resources, and knowledge potentials.

A second, closely related outcome are insights into the mechanisms of globalization and localization in the sense of the research questions mentioned above. It may well be the case that the specification of such mechanisms only makes sense with reference to a global genealogy of knowledge as these mechanisms will probably themselves be subject to the historical development mapped by such a genealogy. A third, more future-bound potential outcome is a characterization and elaboration of approaches that overcome some of the traditional shortcomings of globalization processes of

knowledge, in particular, the association between second-order, normative knowledge and power structures, which constrain the intrinsic dynamics of knowledge development by establishing and maintaining rigid frameworks for the integration of knowledge, and suppress the potentially subversive character of local or globalized knowledge, as the case may be. It would be particularly promising to study the role that the new information technologies could play in overcoming some of the traditional shortcomings of globalization processes of knowledge. Could they lead to a new, dialectical form of globalization in which the integration of local forms of knowledge into global traditions constitutes, at the same time, a contribution to enhancing their local and historical specificity?

This is not the place for attempting even a sketch of a global genealogy of knowledge. What we shall do instead is to briefly review four historical instances of globalization processes of knowledge in a way that may serve as an orientation for future research along these lines. We begin with the spread of culture in the Mediterranean and neighboring regions, continue with the knowledge transfer between Europe, the Middle East, India, and East Asia, then turn to transatlantic colonization and exchange processes, in order to finally address culturally specific knowledge potentials and the import of globalized knowledge that focus on the present situation.

The early cultures of the so-called Ancient World – the Mediterranean and the Black Sea areas, the Eurasian Steppe and the Near East – offer ideal conditions for an analysis of globalization processes as sketched above since they are not only regionally located and transregionally connected to each other but show first approaches of global interdependency. The ancient Mediterranean area and its neighboring regions saw the spreading of early civilizations, the emergence of sedentariness, of agriculture, the rise of the state, the invention of writing, and the genesis of science. The Near East represents, together with Egypt in fact, the most ancient cultural space for which a comprehensive written tradition is available.

The development of sedentariness and agriculture as well as the emergence of cities and states determined global patterns of the interaction between humanity and its natural environment. These global patterns spread much faster than the knowledge required to guarantee the long-term stability of this interaction by adapting it to specific local ecological conditions and limited natural resources.

The invention of writing triggered a specific process of globalization of knowledge which for a long time had, in subsequent historical periods, no parallel because it significantly extended the forms of personalized or object/technology centered transfer of knowledge, transcending their spatial and temporal limitations. This process started with the emergence of writing in the ancient Middle East and Egypt, where it was first used as an instrument of administration for the construction and control of centralized economical systems, then as an instrument for permanently documenting language. Its potential was uncovered only slowly with increasing usage. The globalization of knowledge associated with the spreading of writing led to the emergence of metrologies, calculation techniques and finally to the rise of the first sciences, which may thus be conceived as resulting from a reflection of societal processes of planning labor.

The encounter of diverse cultures in the Mediterranean area and the ancient Near East has repeatedly triggered innovative developments. Their results have synchronically and diachronically reached other cultural spaces. Even in antiquity the transfer of knowledge from other cultures was practiced and was a matter of awareness. With the heritage of late antiquity, and, in particular with Christianity, Judaism, and Islam, the cultures of the ancient Near East have a continuity that reaches far beyond the immediate historical-political presence. In Hellenism, for instance, a hitherto unknown canonization of knowledge took place, eventually shaping – via the transformations of the Arab and Latin literary traditions – the knowledge explosion of the early modern period. Another example for such long-ranging impact is the Islamic legal scholarship of the late Middle Ages which was typically molded by very specific regional and school traditions. In the age of printing and much later in the age of the Internet, single elements are isolated from complex knowledge architectures and exploited for ideological purposes reaching far beyond their regional meaning.

The second historical instance refers to knowledge transfer across Eurasia. The globalization of knowledge due to the invention of writing at first remained restricted to the Mediterranean and hardly reached Asian cultures. Globalization across Eurasia depended on specific forms of knowledge transfer between independent cultural regions, primarily along trade routes, in particular the “Silk Road.” They involved the spreading of “cultural packages” in which material innovations were often loosely coupled with religious, cultural and epistemic innovations. The knowledge exchange between East and West was for a long time closely connected with the spread of and the competition among the world religions. Thus Buddhism spread together with Buddhist philosophy, psychology, and logic as well as with the grammatical thinking necessary for cultural transfer into various linguistic cultures. The spread of Buddhism through the Far East brought with it many aspects of Indian and Sanskrit language and culture. In terms of cultural exchange, India has often been the crossroads between East and West. In antiquity, Indian culture and language diffused widely throughout the Persian empire and Greece. At the same time India accepted cultural imports, such as the writing systems that appeared in the third century B.C., and which were influenced by Aramaic; these are the predecessors of the modern scripts of South Asia, which were used to write Sanskrit as well as the modern Indic languages. Analyzing the knowledge transfer between Europe and the East, one is not simply confronted with the exclusive alternatives of transmission or independent emergence as, for instance, in the cases of the invention of writing and the emergence of science. Rather one may encounter an entire spectrum of interactions, ranging from the production of similar phenomena under similar conditions, which in turn may be partly the result of transmission, to the transformation of knowledge imports into elements of a seemingly indigenous thinking. One deals, in any case, with the interaction of more or less autonomous knowledge traditions of similar levels of sophistication over long periods of time.

A comparison of the beginnings of science in Europe and China, for example, may reveal both the role of transfer and the common conditions under which theoretical knowledge emerges. The striking difference of the further historical development of science in Europe and in China points to another important aspect of the geographical and historical transmission and transformation of knowledge: The eventual success of theoretical

knowledge is also dependent on the historical persistence of the conditions that guarantee its survival. These conditions were given in Europe and lacking in China. As long as the institutions that made scholarly work possible were fragile, the risk that such knowledge was irrecoverably lost with the doom of an intellectual culture was much higher than that of the disappearance of the inherent knowledge of basic practices. On the other hand, in contrast to the knowledge of practitioners, theoretical knowledge can survive over long historical periods in a state of latency as a treasure hidden in manuscripts and prints kept in the safe custody of archives and libraries until they are unearthed again by the renaissance of an ancient culture.

This point may also be illustrated by the transmission of scientific literature from the Greek to the Arabic world which culminated in the eighth and ninth centuries. When the Arabic translation movement emerged, the Greek scientific tradition had ceased to exist for over two centuries. But this case also illustrates the danger of a foreshortened perspective that is restricted to just one line of transmission. In contrast to the situation for the Greek tradition, Persian and Indian scholars, drawing in turn on Greek sources, were still active and could be questioned about the mathematical content of their works. The Greek-Arabic translation movement was thus not just a matter of transmission of texts but a process of the appropriation and transformation of scientific knowledge in an intercultural context. And it may also serve to illustrate the close interaction between knowledge and identity as patronage of the translation movement evidently served the aim of legitimizing the Abbasid dynasty by creating intellectual continuity with the great empires of antiquity and maintaining the cohesion within the various influential ethnic and cultural factions composing the elite of the new society in Baghdad. At the end of the tenth and the beginning of the eleventh century, this tradition was continued at the Mamun Academy in Gurganch and favored by political stability, as well as by the economical and social development of Khorezm at this time. The question in which sense the flourishing of Khorezm also provided occasions for the encounter of different traditions along the Silk Road, including Chinese knowledge, merits further study. Later the Mongol Empire offered a political and logistic infrastructure, which created such transitory occasions for the encounter between knowledge traditions from the East and from the West. In the second half of the fourteenth century and later on scientists and engineers from the Arabic world were employed in Mongolia so that the Arabic scientific tradition, especially its astronomy, had a strong influence on Chinese knowledge.

Another example of a temporary globalization of knowledge is the encounter between European and Chinese science in the context of the Jesuit mission in the sixteenth and seventeenth centuries, which led to a merging of two scientific cultures in a comparable state of development. However, all of these historical developments did not achieve a lasting synthesis, but were interrupted by periods of break-down and isolation. Only in the nineteenth century was a sustainable and politically fostered process of intellectual trade-offs established, which extended well into the conflictual modernization processes of our time. Such globalization processes that take place within independently developed cultures appear particularly suitable for analyzing the appropriation and transformation of knowledge originating in different cultures.

A third historical instance of the globalization of knowledge is represented by the emergence of multiculturalism in Middle- and South-America as a consequence of colonization and the diverse waves of conquest, immigration, and the forced exile of Europeans. Among the consequences of transatlantic exchange are, among others, the suppression or purposeful expropriation of local knowledge traditions, as well as the genesis of new knowledge traditions and pools which are being preserved and continued underground, and which today become the starting points for counter-cultures. An example is provided by the medical knowledge collected by the Kallawaya, a group of itinerant herbalists in the northern part of the present La Paz region of Bolivia. Since time immemorial the Kallawaya have dedicated their lives to the public health of the South American continent. They have undertaken investigations of numerous diseases, chiefly malaria, in order to heal the native populations. Thanks to their research activities on plants, minerals, and animals throughout South America, they have succeeded in developing a real health system. This system grew rapidly on account of exchanges with other native experts of different cultures and varied ecological zones. The Kallawaya thus achieved a synthesis of the continent's botanical knowledge by devising a system of plant classification for medical use. Moreover, they have devoted some research to experiments on mental diseases and actually provide treatments using diverse symbolic therapies.

The emergence of new syncretistic cultures of knowledge in the domains of agriculture, calendar making, medicine, technology, literacy and religiosity may be observed in many contexts of Middle- and South-America. The clash between Maya, Aztec, and Inca traditions with the cultures of European, African, and Asian immigrants has not only destroyed many achievements of sophisticated civilizations but has also given rise to lasting global changes such as the changes in ecological systems – and in the global economy – by the transfer of cultivated plants and biological knowledge. Some of the advanced achievements, such as the complex Maya calendar, partly survived the clash of civilizations in spite of the demise of the indigenous writing system, being passed on by oral tradition. The clash has led, on the other hand, to new forms of external representation of knowledge, in particular the temporary emergence and use of improvised technologies serving the communication and interchange between different cultures, such as writing and accounting systems employed mainly for settling legal issues or for taxation purposes. Further study of these technologies may even provide surprising insights into precolonial communication systems such as that based on the quipus used both in the Inca empire and in the early period of Spanish occupation.

The encounter of European knowledge cultures, brought to Middle- and South-America in many different phases of immigration, with indigenous traditions as well as with an unfamiliar natural environment has been a starting point both for scientific breakthroughs and the formation of local academic traditions. Darwin's formulation of his theory of evolution, for instance, would have been hardly conceivable without the global integration of knowledge about the natural world that was made possible, in particular also by transatlantic exchange processes. The formation of local traditions of science and education today represents an important aspect of the national identity of Latin American countries and even of those regions of the Old World such as the Canary Islands that have played an important mediatory role in this exchange process. The integration of these local

traditions into the global division of labor in science constitutes today a key challenge of Latin American science policy, which includes the creation of curricula integrating global and local knowledge, and new forms of the popularization of science that address specific societal challenges as well.

To assess the relevance of the results of the investigation of historical processes of globalization for the present situation, such results must be related to today's encounter between culturally specific potentials of knowledge with globalized knowledge, which constitutes the fourth instance of the globalization of knowledge considered here. Of particular interest is the question how the Web has created new conditions for the development of this relation and the global division of labor in science. Nuclear and particle physics have long relied on international collaboration and have developed an advanced culture of acquiring and openly sharing knowledge. International and global collaborations have been necessary to construct the complex instruments required to create and study events of interest in order to gain new insights. Open, continuous communication, open sharing and transparent organization of and access to all knowledge gained are essential ingredients of this particular collaboration. It would be of great interest to identify and understand similar methods of knowledge acquisition and sharing in other scientific fields and to elaborate common visions of how to obtain, share and communicate scientific and technological results.

A typical illustration for the ambivalence of today's encounter between globalized knowledge and local knowledge potentials is the spread of nuclear technologies. The intrinsic dual-use of these technologies has been the concrete basis for the proliferation of nuclear armaments. The analysis of such technology diffusion processes may reveal new insights into the role that different layers of the globalization process play in their enhancement as well as in possibilities of steering them.

Patterns of the globalization of knowledge to be identified in the course of further research might also be validated by comparing them with insights into information networks of completely different kinds, ranging from studies of the communication patterns in the Web to information networks based on biological systems. In such systems, the spread of information is thought to be mediated by a proliferation of the genetic propensity to utilize that information. As an example one may consider the spread of information within a network of ecological interactions involving plants, herbivores, and predators that are recruited to attack herbivores close to the plant. Such an investigation could address fundamental questions about the mechanisms of learning in these systems, how the ecological consequences of this learning process are "globalized" across habitats, and how these processes could in turn influence the human-driven globalization of sustainable agricultural methods.

The case of Latin America is particularly suited to study the encounter between culturally specific knowledge potentials and globalized knowledge. At the beginning of the twentieth century scientific institutions in countries such as Argentina, Brazil, Cuba, and Mexico began to be modernized under the influence of specific national traditions from developed countries, often under the spell of specific political and economic interests. Comparative studies of these modernization processes may reveal the extent to which these different influences yielded new "globalized" forms of knowledge or at least independent

intellectual traditions that must be taken into account when addressing the challenges of today's globalization processes.

In summary, it makes sense to launch a research initiative in the field of globalization processes with the aim of integrating diverse studies of the conditions, pathways, and consequences of historical globalization processes of knowledge, and relating them to present processes of globalization, in particular those involving the development of the Internet and the global organization of science. Science in the twenty-first century depends not only on the creation and exploitation of new social and technological structures, which permit a free flow of knowledge and expertise globally, but also on a historical awareness of the ways in which techniques and technology have in the past spread throughout the world. It is here that such a research initiative can make a much needed contribution.

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