UNITY OF KNOWLEDGE IN TRANSDISCIPLINARY RESEARCH FOR SUSTAINABILITY

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Contents

Summary

Today, there is a social need for a comprehensive unity of knowledge that would provide orientation and ensure action in the context of the complex problems of modern civilization. Based on an intellectual need for unity of knowledge, different concepts of unity of knowledge have emerged in the course of the history of ideas. The intellectual need for unity can be directed at the world, science, action or the individual. It can involve the quest for the unity of the world based on a principle that is immanent in it, the unity of science as a theoretical, methodical or epistemological unity, the unity of action as a correlation of scientific, pragmatic and moral knowledge or, finally, unity as the educational task of the individual. The concepts associated with unity of knowledge can go in two directions. The first assumes that there is a unity existing in the world that can be perceived by man. It is thought of as an order of being, i.e. an ontological unity of the plurality of phenomena, that consist in their common nature. The other direction is based on the assumption that unity is a construction of a subject, based on its cognitive principles and structures. Thus it is not something that can be discovered as an existing objective order, and is instead subjective. Various concepts of unity of knowledge that correspond to these two directions can be found in the history of ideas. For example, some concepts refer to an essential metaphysical principle of things in the

world or principles of reason as the basic components of a knowledge system. We also have materialistic reductionism and general systems theory as an overall concept for the structuring of problems in the natural and social sciences etc. In the face of the current threats to our life-support systems, the correlation of knowledge about states and processes (scientific knowledge), will (moral knowledge) and how to do things (pragmatic technical knowledge) is an issue of extreme urgency. As opposed to this, the quest for such a correlation did not arise in antiquity as there was no systematic relationship between knowledge and action. The linking of knowledge and action first arose with the development of the experimental natural sciences in the modern age, which expressly placed the sciences at the service of general human welfare. The need for unity of knowledge in transdisciplinary research for sustainability arises from the concern about the risks posed to life-support systems as a result of the manifold and poorly understood negative side-effects related with the increasing use of nature to sustain an ever-expanding population. Research for sustainable development relates to issues which do not arise primarily from the scientific disciplines themselves, but for which there is a social need for orientation and action strategies, that cannot be answered adequately by disciplinary experts. These issues do not fit in with the cognitive and social organization of the sciences in disciplines and subjects. In the context of societal problem-solving, unity of knowledge is a complex issue. The task here is to incorporate the correlations between a wide variety of phenomena in an integrative unit so that measures deemed suitable from a sustainable development perspective can be implemented to resolve the problems in question. The knowledge subject here is a team whose composition is based on the nature of the problem, whose members have different competencies and often include non-academic actors. The work of such teams requires suitable concepts and organizational forms of cooperation. The aim is to create a unity of causal, pragmatic and moral knowledge which also incorporates the knowledge of societal actors. In such a context, science is confronted with major uncertainties with regard to natural processes and the possible consequences of use practices. In terms of society, the aim is to find solutions in tune with the sustainable development model to conflicts concerning objectives that can arise between different action orientations and use practices. As a result, mutual dependencies arise between scientific research and economic and social processes.

1. Introduction

The quest for unity of knowledge has been associated with Western science and philosophy since their inception. In the course of the second half of the twentieth century, social motives gradually joined the intellectual motives that had traditionally fuelled the quest for unity of knowledge in the history of ideas. These social motives reflect a deep concern for the global economic, social and ecological problems facing humanity and the problems of control in global society. The nature and scope of these problems are endangering the future of humankind on our planet. The intention behind the sustainable development model, on which over 180 states reached agreement at the UN Conference on Environment and Development in Rio de Janeiro in 1992, is to provide viable orientation for the future and create an obligation for action in accordance with the principle of justice for today's and future generations. In a nutshell, the sustainable development model requires that natural, social and economic life-

support systems only be used for human welfare purposes in a way that does not pose a risk to their survival, and that the needs of the poor take priority in this process.

In view of the complex interdependencies that exist between economic, social and ecological developments, knowledge of the use and conservation of life-support systems plays a crucial role in sustainable development. Thus, the involvement of science and technology in the challenge of sustainable development is multiple in nature. Without science and technology we would be unaware of many risks or existing damage caused by modern civilization, for example, the depletion of the ozone layer, climate change, soil degradation etc., the anthropogenic factors involved in these processes and their actual and possible consequences for nature, economy and society. Without science and technology as knowledge bases, it is unlikely that we would have today's levels of demographic growth or the distribution conflicts and threats to civilization posed by industrial and post-industrial society which now dominate as models of civilization.

Needless to say, the historical development of civilization cannot be explained in terms of the progress made in research alone. As sociologist Max Weber acknowledged in the early twentieth century, the global dominance of Western civilization is down to the three following factors: modern science, the capitalist market economy and the efficient bureaucratic organization of secular society. The progressive achievements and global spread of Western civilization arising from them would not have been possible without the parallel differentiation and specialization between and within science, economy and social institutions.

In the context of the problems of industrial and post-industrial society, however, it is the factors behind the highly ambivalent and therefore contested development of modern civilization that are currently the target of criticism. World economy and society has reached limits to growth in various respects while the gap between the rich and the poor is still getting bigger which increases the potential for conflicts and terrorism. The growing differentiation and specialization in all areas is increasingly also being seen as the cause of the problems of control in modern civilization which hinder or impede the implementation of effective solution strategies. Thus, in the context of political strategies for sustainable development, the Brundtland report on "Our Common Future", which put sustainable development on the international policy and economy agenda, stresses the shift from sectoral policies towards intersectoral cooperation and coordination in an effort to overcome narrow preoccupations and compartmentalized concerns which are seen as being among the most important causes of non-sustainable development paths. Thus, the report defines itself as a "global agenda for change" in national and international institutions that will transform the rules of social and economic practice.

Understood as a "global agenda for change", the sustainable development model also poses a particular challenge for science. When it is a matter of conserving the human life-support systems at risk from multiple and expanding uses, the desire is for research to provide information as to how the global and local changes in natural, social and economic systems relate to use practices, how the changes in the different systems affect each other, how the use practices should be judged from the perspective of sustainable development and how they can be improved. However, the differentiation of

scientific disciplines, which mainly started in the nineteenth century, has resulted in a specialization of research which is directed at methodical and theoretical progress in specific subjects. The concrete processes in the life-support systems depend, however, on a variety of heterogeneous and often coincidental factors that cannot be adequately covered from the perspective of individual disciplines. Today, there is a major social need to understand and order the myriad concrete processes in the world and their dynamics in such a way that they can be effectively taken into account in the realm of action.

The expertise provided by highly specialized fields is not able to adequately fulfill this need for a comprehensive unity of knowledge that provides orientation and secures action in the context of the complex problems of modern civilization. However, simply to dismiss experts as people who know everything about nothing would be to throw the baby out with the bath water. Firstly, their expertise may be needed when explanations are sought for unexpected processes, such as the depletion of the ozone layer and, secondly, the form that a better alternative or addition to the existing system should take is far from clear. However, people who know "nothing about everything" are unable to provide the necessary guidance and do not have the necessary knowledge at their disposal to ensure action. It remains to be clarified whether and how the relations between the multiple changes to our natural social and economic life-support systems are conceivable in an ordering, what can be reasonably meant or aimed at by unity of knowledge in this context and how it relates to specialist expertise.

Unity is not just a current social need; it is an old intellectual need that existed in the Western history of ideas long before the advent of the large-scale differentiation of scientific disciplines in the nineteenth century. As an intellectual need, unity is a philosophical dream. We cannot hope to find answers to today's questions in old or new philosophical dreams. However, the knowledge of these dreams can help us to reach a deeper understanding of our current need for unity of knowledge in transdisciplinary research for sustainability, and it can protect us against hasty simplifications that are not suited to the problems we need to solve.

The intellectual need for unity can be directed at the world, science, action or the individual. It can therefore involve the quest for unity in the world based on a principle that is immanent in it, the unity of science as a theoretical, methodical or epistemological unity, the unity of action as the correlation of scientific, pragmatic and moral knowledge or, finally, unity as an educational task of the individual. Some approaches to this question that emerged in the course of the history of ideas are described in the next section. The following section explains the concept of sustainability and the different roles of science and society in the process of sustainable development. Finally, it is demonstrated how the question of unity of knowledge arises in transdisciplinary research for sustainability and the associated implications for research are explored. The historical, conceptual, methodological and institutional aspects of transdisciplinary research for sustainability are then discussed individually in the various chapters of this Theme.

2. Unity of Knowledge in the History of Ideas: Ontological and Subjective Concepts

Unity cannot only be sought in relation to knowledge. We also speak of the unity of the person, a currency unit, the unity of a work of art, the unity of a people, world unity etc. The word unity is not only used in all possible contexts, it can have different and even contradictory meanings. It can be used to describe a numerical unit, an individual in relation to a group, a whole as distinct from its parts (insofar as it comprises a unity of parts), the identity of a person etc. This shows that unity and plurality are correlative concepts: unity can only be meaningfully sought in relation to a plurality. However, the relationship between unity and plurality can be understood in different ways. On the one hand, unity can be seen as the origin of a plurality or as the objective towards which it is moving. On the other, it can be seen as a common denominator that holds a plurality together or as an indivisible whole.

The approaches to the question of unity of knowledge can go in two different directions. The first direction presumes that there is an existing unity in the world that can be perceived by man. It is thought of as an order of being that is the uniform essence or nature behind plural phenomena, a so-called ontological unity. This is not directly sensorily accessible to us, instead we must behold it or infer it in our minds. The other direction that may be taken in seeking a response to the question of the unity of knowledge assumes that unity is a construction of a subject based on its cognitive principles and structures. According to this approach, unity of knowledge arises in the creation of order which is based on structures imposed by the mind of the knowing subject, and is, therefore, subjective.

European philosophy started in classical antiquity with the exploration of the question of the origin or source of the world, from which all things arise and to which they also necessarily pass away again—as expressed by Anaximander. The pre-Socratic philosophers, Plato and Aristotle were also preoccupied with the question of ontological unity and the topic was taken up again in the philosophy of the Middle Ages. Modern ontological conceptions of unity also exist, for example in certain holistic streams (see *Holism in the Sciences,* and *Philosophical Holism)* and in the New Age movement. In this orientation, the unity of knowledge is based on the ontological unity of the world.

The pre-Socratic philosophers sought a single reason and end for all transformable things: “all is one” as stated by Heraclitus. If we try to interpret this statement, it quickly becomes clear that not only is unity correlative with plurality, it is loaded with other antitheses such as existence or non-existence, sensorily perceptible or comprehensible through pure thought, finite or infinite, static or transformable. Ontological unity can be understood in such a way that, despite the variety and plurality of phenomena, ultimately there is no Many but just One, and unity is, therefore, the being or subject. This is the position adopted by Zeno who demonstrated numerous paradoxes, in which anyone who assumes that plurality and change exists becomes entangled. As opposed to this, Plato proposed a dialectical relationship between unity and plurality saying that One is at the same time Many and Many is not just Many but also One. Hegel believed that in expressing this Plato grasped the basic principle of speculative thinking. Plato makes a distinction between the absolute One and the existing One. The absolute One is

the unconditional origin and principle of the existing One as a plurality and totality of the characteristics which Plato calls the *Idea*. Thus, for Plato, unity is something transcendent, in which many individual things that are mediated through the ideas participate.

Ontological unity can, however, also be understood in such a way that everything that exists is one in the sense that as a whole it is indivisible. Understood in this way, unity is a predicate of everything that exists, but not as an additional characteristic of the things, but in the sense of being as being One. This is the position adopted by Aristotle. Aristotle understood unity not as a transcendent idea, but as a principle within things. He explains the reason for and purpose of the transformation in all things in terms of a dynamic principle of unity within the things themselves as their measure which he calls *entelechy*. The being or essence of things, which according to Aristotle includes living things and things produced by man, is their process character. The process character arises from the fact that each thing is an indivisible dynamic unity of material and form: a thing originates, develops and passes away. In the case of natural things this process brings the form inherent in the thing as potentiality to fulfillment in finite reality, after which the thing passes away and the enduring form is realized in a new individual. Thus, unity in this context means the numerical unity of the individual, on the one hand, and the generality of form as the specific unity of all individuals in a species or kind, on the other.

In the Middle Ages, the problem of unity and the One assumed a special significance for the philosophical foundation of monotheism and the concept of man as God's image. Augustine and Boethius identified the main questions of philosophy as concerning God and the soul and they understood these as issues concerning the One. The views that emerged during this period continued the Platonic approach of a transcendent unity, on the one hand, while, on the other hand, orthodox metaphysics adopted the Aristotelian approach which understands being and One as interchangeable.

In terms of the development of the concept of unity, the most important approaches that emerged in the modern era include those developed by Baruch de Spinoza, Gottfried Wilhelm Leibniz, Immanuel Kant and Georg Wilhelm Friedrich Hegel. The systems philosophies of the modern age understood a rational-theoretical reinterpretation of the ontological concepts of unity and prompted a shift towards subjective concepts of unity. In this context, unity of knowledge consists in the systematic derivation and hence justification of knowledge from a general supreme principle of reason. This reason may be divine or human. For Spinoza, there is only one true substantial unity, i.e. God. God is the origin of Himself (*causa sui*) and thus stands out as a unity through a relation to Himself. As opposed to this, as a plurality, things are merely ways of being other and thus indicate a limit of unity. Leibniz adopted the opposing view of pluralism. For him, things are entities that differ from each other: he referred to them as *monads.* Leibniz interpreted the unity of the world in the context of the pluralism of the monads as consisting in the fact that all monads are linked through the material bond and each monad reflects the entire world in itself. Thus, Leibniz understood the monad as a unity from the perspective of both Aristotle's entelechy and the subject or "I" of the modern age.

This shift towards the subjective origin of unity was consummated with the work of Kant. For Kant, unity in general—the unity of things, the world and knowledge—is based on a capacity for reason, the structuring of the multiplicity of phenomena according to rules and the ordering of both the knowledge and the phenomena on the basis of these rules. Hegel radicalized this idea by stating that not only unity, but also plurality originates from the spirit. For Hegel, the plurality of existing things originates from the dialectical self-determination of the spirit from abstract to concrete unity. Thus, unity for Hegel is a movement, the so-called negation of the negation, a self-determinating process, in which abstract unity creates plurality as a negation of unity and, as the plurality of unity, in turn negates this plurality and cancels it in a concrete unity. Thus, for Hegel "all of philosophy is nothing more than the study of the determinations of unity", that is the absolute as unity of being and reason, which can be known by speculative reasoning.

This speculative idea of unity was overturned in the twentieth century when difference was given priority over unity. Late-twentieth-century Post-Modernism asked whether the quest for a unity of (scientific) knowledge was a meaningful exercise in the first place. It stayed with fundamental pluralism, thus sacrificing unity to plurality. In an entirely different context, Niklas Luhmann developed a conception of the priority of difference as part of his theory of social systems as open systems. Luhmann disregarded the distinction between unity and plurality as whole and part that is central to the theory of unity. Instead, he started with a distinction between system and environment and used the terms of integration and differentiation to describe empirical processes or states of unity or plurality. According to Luhmann, development consists in the progressive internal differentiation of subsystems which in turn differ from their environment and cannot be integrated into a unity. Thus, Luhmann counters Hegel's dialectical principle of the identity of identity and difference with the principle of the difference of identity and difference. In rejecting unity *per se*, both Post-Modernism and the theory of social systems fail to resolve how the co-existence and relations between diverse elements should be explained.

The quest for an ontological unity of the world remained on the agenda of the natural sciences in the second half of the twentieth century. It encompassed, on the one hand, spiritually inspired concepts, such as James Lovelock's GAIA hypothesis that the earth is a living, self-regulating organism, and the New Age movement which supports holistic thinking and a unity of spirit and nature (see *Holism in the Sciences).* The manifesto on Transdiscipinarity by Basrab Nicolescu and the writings of a group of scholars linked with the International Center for Transdisciplinary Research and Studies (CIRET) in Paris also contribute to sketch an ontological unity of the world in contrast to modern science. Their ideas are based on principles about multidimensional realities and principles of thinking alternative to binary logics. These principles are developed from quantum physics.In all of these various approaches, unity is seen in uniform structures or patterns at the basis of pluralistic processes and their dynamics. But also materialistic approaches, such as Edward O. Wilson's *consilience*, emerged in this period. In Wilson's opinion, there are ultimately only a few natural laws, which can explain all natural processes and social and cultural developments, including art and morality. Wilson suggests that a connection exists between these laws which he is unable to explain exactly but which is neither logical nor metaphysical.

The risks that the development of mankind pose to the survival of our life support systems indicate that all the different changes that mankind causes in nature, economy and society are somehow causally connected. This gives reason for an unrevealed unity of the world. But it is doubtful whether the concepts developed in the history of ideas are of much help for a better understanding of this unity. Concepts of unity as a metaphysical essence as well as reductionist approaches of materialism fail to capture the correlations between these manifold processes, because they disregard differences and plurality for the sake of a universal but abstract unifying principle. The same problem arises with the subjective concepts of unity which are based on universal cognitive principles and structures for ordering problems in various fields. In transdisciplinary research for sustainability the quest is not for unifying but for integrating differences of the manifold processes in life support systems, which are described, analyzed and interpreted in disciplinary research. Thus unity of knowlege in transdisciplinary research for sustainability has to address unity and diversity of the sciences and humanities.

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Bibliography

Apostel, L. et al. (eds.). *Interdisciplinarity. Problems of teaching and research in universities. Centre for Educational Research and Innovation* (CERI). Paris: OECD. [The classical source book for conceptual problems of interdisciplinarity and transdisciplinarity]

Bammer, G. 2005. Integration and implementation sciences: Building a new specialization. Ecology and Society 10(2), online [Systems thinking and complexity science, participatory methods and knowledge management are the three pillars for transdisciplinarity as integration and implementation]

Benson, G., Glasberg, R. & Bryant, G. (eds.) (1998*). Perspectives on the unity and integration of knowledge*. New York et al: Lang. [Discusses recent approaches to the integration of knowledge from cultural and theological perspectives in educational contexts]

Campbell, D.T. (1969). Reforms as experiments. *American Psychologist* **24**(4), 409-429. [Seminal paper on problems of validity of knowledge when transferred from research settings into real situations]

Carnap, R. 1928/1969. *The logical structure of the world and pseudoproblems in philosophy*. Berkely: University of California Press. [Classical statement of the unity of science from the perspective of logical positivism]

Funtowicz, S. O. & Ravetz, J.R. (1993). Science for the Post-Normal Age. *FUTURES*, September 1993, 739-755. [Introduces the concept of issue-oriented research and analyses the interdependencies between science and society]

Galison, P. & Stump, D.J. eds. (1996). The Disunity of Science. Boundaries, Contexts and Power. Standford [reports on the historical and current discussion on unity of science from a social studies of science perspective].

Hirsch Hadorn, Gertrude; Bradley, David; Pohl, Christian; Rist, Stephan & Wiesmann, Urs. Implications of Transdisciplinarity for Sustainability Research. Ecological Economics, online [Explains relations among transdisciplinarity and sustainable development with an emphasis on north-south research partnerships]

Hoyningen-Huene, P. (2000). The Nature of Science. In Cetto, E.M. (ed.). World Conference on Science. Science for the Twenty-First Century: A New Commitment. Paris: UNESCO, 52-56. [Describes science as systematization in various dimensions].

Fisher, D. 1990. Boundary Work and Science: The relation between power and knowledge. In S.E. Cozzens and T.F. Gieryn (eds.) *Theories of Science in Society*. Bloomington: Indiana University Press, 98-119. [Explains the concept of boundary work as transdisciplinary research in social studies of science and technology]

Dobson, A. ed. (1999). *Fairness and Futurity. Essays on Environmental Sustainability and Social Justice*. Oxford: University Press. [Includes contributions on justice in sustainable development]

Klein Thompson, J. (1983). *Interdisciplinarity. History, Theory, and Practice*. Detroit: Wayne State University Press. [Classical source book for the analysis of interdisciplinary research and education]

Kocka, J. (ed.) (1987). *Interdisziplinarität: Praxis – Herausforderungen – Ideologie. (Interdisciplinarity. Practice – Challenges – Ideology*) Frankfurt am Main: Suhrkamp [Analysis of studies at the first and influential German Post-Graduate College for Interdisciplinary Studies in Bielefeld].

Kokelmans, J.J. (ed.) (1979). *Interdisciplinarity and Higher Education*. University Park and London: The Pennsylvania State University Press [Reflects the discussion in the USA in the 1970s with a focus on different concepts of interdisciplinarity, cross-disciplinarity and transdisciplinarity as well as their methodological and administrative problems in education].

Marquard, O. (ed.) 1987. Einheit und Vielheit (The One and the Many). Hamburg: Meiner. [Reader with philosophical contributions on the One and the Many in metaphysics, ethics, philosophy of science and other areas]

Pohl, Christian & Hirsch Hadorn, Gertrude 2006. Principles for Designing Transdisciplinary Research. Oekom: München [Describes principles for designing transdisciplinary research projects]

Schellnhuber, J.H. (1999). "Earth System" Analysis and the second Copernican revolution. *Nature* **402**, SUPP, DEC 2, 19-23. [A systems theory approach in transdisciplinary research on global change].

Whythe, W.F. ed. ((1991). *Participatory Action Research*. Newbury Park CA: Sage. [Collection of important articles on Action Research].

World Commission on Environment and Development (WCED) (1987)*Our Common Future*, Oxford; University Press [Puts sustainable development on the agenda of international politics and business].

Biographical Sketch

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