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A critique of knowledge-based development

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1. Introduction

This paper draws on the ‘process philosophy’ of Alfred North Whitehead. This review is oriented by a desire to implicitly question the economic geography literature on the ‘Knowledge Base’. To make this account more readable much of the material presented here will approach the work of Alfred North Whitehead in an informal rather than a technical manner. Accordingly, the paper will extract pertinent observations from some of the more significant contributions to the burgeoning secondary literature that has focused on Whitehead’s philosophy: primarily, that of Isabelle Stengers, the Belgian philosopher of science, and Bruno Latour, the French sociologist of science.¹

Whitehead distinguished between what he called ‘organicism’ or the philosophy of ‘organism’ and ‘atomism’. For him, organism was a metaphysical alternative to the concept of substance. Under ‘organicist’ ontology, the (internal) relations holding between entities determine the characteristics of each individual entity. In Whitehead’s terminology, the entity is an ‘adjective of its situation’. This contrasts with an atomistic ontology, for which the essential attributes of entities are determined independently of (external) relations with other entities. In other words, the atomic hypothesis falsely presumes that the identities of individual entities remain unchanged with changes in their relations (Winslow, 2005).

Whitehead overcomes the problems associated with an organic ontology by recognizing the ‘nested’ character of being. His ontological ranking distinguishes between wider, more general, and thus more stable, systems which are conceived to be subject to a smaller number of factors of influence and narrower, more specific, and thus less stable, systems exposed to a far greater range of influential variables. For example, it is easier to make inferences and predictions about the behavioural properties of living things in their generality compared to those of human beings, or even a particular category of human beings such as those who belong to the entrepreneurial class. In much the same way it is easier to make predictions about the near future than the distant future. The shorter the distance into the future of events to be forecast, the greater is the number of factors that can be treated as given. The further into the future are the event to be predicted the larger the reduction in what can be treated as given, and the smaller the amount of knowledge available for purposes of prediction.

Whitehead’s fundamental ‘ontological principle’, which states that ‘there is nothing which floats into the world from nowhere’ is expressed through a variety of strange concepts including ‘eternal objects’ and ‘God’, standing in the way of an intuitive understanding of the world as a ‘creative, spontaneous becoming’. This is because Whitehead’s task is not to ‘go beyond abstractions’, but to ‘take care of our abstractions’. Abstract propositions do not abstract from what would be more concrete, rather, they elicit interest by acting as a lure for imagination and feeling. Far from disclosing the truth of the world, they engender a feeling that something matters. Thus Stengers proclaims that, for Whitehead, there can be no ultimate or right perspective, because as soon as we define a settled position of knowledge about something out there we are left with ‘the dead abstraction of mere fact from the living importance of things felt’ (Whitehead, 1968: 11). What matters is what induces a variation in interest or a shift in perspective.

The subject arises in the very act of what Whitehead calls ‘concrecence’ or becoming together, becoming as one—the self-production of an actual occasion. With the concept of ‘actual occasions’, Stengers (2006) argues that Whitehead undermines the privilege accorded to the explanations of the physical sciences. Temporally atomic actual occasions achieve an ‘objective immortality’ through satisfaction: the accomplishment of subjective self-determination. Continuous identities must be produced out of discontinuity. All occasions are also new occasions, breaking social continuities. When we confront rocks, electrons, rabbits,

¹ A more technical overview of Whitehead’s philosophical arguments in *Process and Reality* is presented in Juniper (2007).

or human beings as things that endure we confront ‘societies’ rather than actual occasions, which are instantaneous and atomistic. Societies endure because some actual entities ‘accept in their own becoming to conform to a common feature that other entities they have to feel, also accepted, also conformed too’ (Stengers: 2005: 47).

Those aspects of Whitehead’s philosophy concerning education and learning will be discussed in Section One, where emphasis will be placed on the notion of ‘learning to be affected’, the dual nature of modes of perception, and the nature of creativity. In this Section, the ideas presented in Whitehead’s essay, ‘The Aims of Education’, will also be reviewed. The process of tacit inference features strongly in the geographical literature on proximity-effects and inter-firm relations. Section Two canvasses current debates in urban and economic geography, which attempt to characterise the nature of the knowledge base in different regional and industries Michael Polanyi’s insights into the nature of tacit and codified knowledge feature here. Critical commentary follows in Section 3, while Section 4 presents conclusions.

2. Whitehead on Education

2.1 Modes of Perception

One of the crucial distinctions that Whitehead draws upon is his discussion of education is that between the two modes of perception: causal efficacy and presentational immediacy. For Whitehead, the former is primordial, thus inverting Hume’s dogma that all percepts are in the mode of presentational immediacy, in turn implying that our construction of causal relations is an illusory process entailing the mere imputation of cause through a kind of mechanical association. While Whitehead (1978: 176) describes presentational immediacy as a process lifting into clear, distinct prominence and relevance the ‘extensive’ relations of the contemporary world, causal efficacy is instead characterised by an ‘extreme vagueness’. This is because it entails a consciousness of the ‘settled world in the past as constituted by its feeling-tones, and efficacious by reason of these feeling-tones’ (Whitehead, 1978: 121).

Myer (2005: 21) introduces Whitehead’s (1978: 121) associated distinction between ‘visceral feelings’ (which are described as more closely related to the perception of causal efficacy) and ‘visual feelings’ (which are described more closely related to perceptual immediacy). For Whitehead (1978: 176), the role of the former class of feelings help to explain why the ‘inhibition of familiar sensa’ leaves us prey to ‘vague terrors’ and ‘presences, doubtfully feared’. However, Myer (2005: 21, citing Whitehead, 1978: 176) also observes that bodily experiences—that is, the *witnness* of the body—in the mode of causal efficiency, are distinguished, principally, from ‘causal influences [derived] from the external world [...] by the comparative accuracy of spatial definition.’ Moreover, for Whitehead the two modes of perception always occur in combination in what he terms the mode of symbolic reference. And when one mode is interpreted by the other error emerges². Myer concludes his discussion of perceptive modes by citing Whitehead’s (1978: 50) remark that, as a result, ‘we find ourselves in a buzzing world amid a democracy of fellow creatures,’ suggesting that the latter’s philosophy entails a working out of the implications of this being present *in* another entity³.

² There can also be admixture of modes due to symbolic reference between two species in the same perceptive mode, which Myer (2005: 22) interprets to mean synesthesia or other confusions of the senses.

³ Myer (2005: 22-32) concludes his wide-ranging paper with a review of the neuroscientific evidence pointing to the role of the associative cortex, believed responsible for the integration of sensory and motor functions, as a neural substrate not merely for synesthetic experience, but also for perception in the mode of causal efficacy, and for combining such perceptions with those in the mode of presentational immediacy, resulting in the mixed mode of symbolic reference. He adds that all forms of suggestiveness involve reentry to these same areas of the brain (Myer, 2005: 32). Thus, Whitehead’s revision of Hume interweaves suggestion and association “in acts of experience involving consciousness no less than in actual entities that remain fully unconscious” (Myer, 2005: 33).

2.2 Learning to be Affected

Latour (2004: 205) suggests that Whitehead drew from the pragmatism of William James, the principle that ‘to have a body’ is to ‘learn to be affected’. As an interface, the body becomes more describable as it learns to be affected by more and more elements. Here, Latour draws on the example of odour kits as described by Geneviève Teil that are used to train ‘noses’ for the perfume industry. Training in recognition of an array of different fragrances enables the trainee to inhabit a rich world of differentiated scents and odours that were previously merged together into a far smaller number of ill-defined contrasting smells. This model should be contrasted with one that views language or ‘odour kits’ as a merely passive intermediary dissolving once meaningful connections have been established between the autonomous subject and the external world (Latour, 2004: 208). The ever-present temptation is now for the philosopher of science to establish accuracy or veracity by distinguishing between two accounts of odour. On one hand there is the scientific world of chemicals, pheromones, chromatographs, and neuro-transmitters, a world of primary qualities, on the other hand there is the derived world of secondary qualities existing only in the imagination of the all too human observer. Thus, the phenomenological body offering something ‘more’ than chemistry is split from the physiological body of scientific investigation. This ‘bifurcation of nature’ was something vehemently opposed by Whitehead. Yet the bodies in question, that of the scientist and that of the perfume ‘nose’ each have to be trained through the use of diverse apparatuses of measurement and discrimination—both human and non-human.

Whitehead overcomes this bifurcation of nature through a metaphysical inquiry into what he calls ‘process’. Whitehead’s (1978: 23) ‘principle of process’ states, ‘*how* an actual entity *becomes* constitutes *what* an actual entity is.’ Stengers (2005) draws specific attention to Whitehead’s use of the term ‘becoming,’ contrasting it with transcendent and static notions of ‘being’ including, here, what is merely ‘given’ to experience. Whitehead (1978: 22) defines the ‘becoming’ of an actual entity as that whereby ‘the potential unity of many entities in disjunctive diversity acquires the real unity of an actual entity.’ This should not be conceived as the mere unfolding of a unity already there in potential.

The articulate subject learns to be affected by others rather than by itself. It only becomes profound, interesting, deep, or worthwhile when it resonates with others (Latour, 2004: 210). Local, material, and artificial differences are registered through a process of learned articulation so that different odours no longer elicited the same behaviour on the part of the perceiver. The more contrasts are recognised, the more differences one becomes sensitive and sensible to, the wider the world becomes, with no presumption of convergence to one true model (Latour, 2004: 211). As argued by Whitehead, propositions rather than statements of fact describe whatever is articulated. While propositions convey a stance or position, they have no definitive authority, and can accept compromise or co-positioning without losing their solidity (Latour, 2004: 212).

Drawing once more on the work of William James, Latour introduces the concept of a ‘multiverse’, which is defined as the ‘universe freed from its premature unification’ (Latour, 2004: 213). While the universe is made of essences, the multiverse is made of habits. However, in moving beyond a normative sense of correctness—such as would apply to correct and incorrect statements—this raises the question of how to discriminate between well or badly articulated propositions (Latour, 2004: 214). Following Stengers, Latour argues that science must be interesting and risky, it must provide opportunities to differ, thus establishing good rather than bad generalizations, which in turn allow for a common world.

Good science, Latour suggests, is rare and cannot be transported to other instances: natural, social, or human. Interesting research is fecund, it provokes richness, originality, and elegance in both scientists, objects of study and the articulations themselves. Articulation leads beyond tautology, mere correspondence, and repetition (Latour, 2004: 215-6). The biases and prejudices of the scientist must be openly acknowledged, but more than this, they must be *put at risk* (Latour, 2004: 218). Risk, as Stengers conceive it, is irreducible to falsification. Rather, it conveys the notion of asking the right questions of a recalcitrant and highly specific domain, because it provides opportunities for the object of study to resist, or to counter a particular line of questioning with an alternative set of categories (Latour, 2004: 217). The distance between the previously existing repertoire of actions and the newly created repertoire must be maximised, not the distance (nor for that matter the empathy) between the observer and the observed (Latour, 2004: 219).

Thus, what is truly scientific is discourse that allows propositions to be more articulate; one that enables more questions to be raised, systematically jeopardizing former versions of a given domain of events pertaining to the multiverse. Certainly, scientific explanation must be parsimonious, but good generalizations enable the researcher to connect 'widely different phenomena' and 'recognise unexpected differences', whereas bad generalizations produce a spurious generality through the 'discounting of all remaining differences as irrelevant' (Latour, 2004: 220). Science must extricate itself from an 'eliminative' approach to questions of knowledge. Latour instances the research of Prigogine and Stengers into self-emergent complex systems, which was motivated by the desire to connect a Newtonian and Quantum mechanics characterised by reversible time with a statistical mechanics characterised by irreversible time.

The final aspect of good science as Stengers describes it, is allowing for a common world. Here, politics is restored to epistemology. The issue is not to isolate science from the 'vagaries of politics' like Karl Popper, but to distinguish well-articulated propositions from poorly articulated and redundant ones, both in politics *and* science (Latour, 2004: 222).

In the last chapter of *Process and Reality*, Whitehead describes the threefold nature of God, conceived in terms of (a) the conative urge towards realization; (b) the formal principle of concrescence; and (c) the ground and expression of accidental creativity (1978: 11, 135). The primordial nature of God is deemed necessary but deficiently actual because He is dependent on actual occasions for developing his consequent determinate nature through a process of self-creation. For Whitehead (1978: 522, 524), God is not a Spinozan substance, yet attributes are assigned to him insofar as he is conscious of the inter-relation between things as a unity. As objects become events, these also exist as God's ideas (1978: 523). Accordingly, despite their transience they enjoy an objective immortality. This conception follows closely on the heels of Spinoza's discussion of the role played by the common notions in the constitution of what he calls the second and third kinds of knowledge.

Knowledge of the first kind (opinion or imagination) obtains when we form universal notions either from singular things represented to us through the senses, but in an unordered or confused way (Spinoza calls this knowledge from random experience), and from signs or ideas of things that we have heard or read about that we recollect (Spinoza 1996: II, P40, S2). Knowledge of the second kind (reason) arises from common notions or adequate ideas of things; while knowledge of the third kind (intuition) proceeds from an adequate idea of the formal essence of certain attributes of God to the adequate knowledge of the formal essence of modes or things (Spinoza 1996: II, P38-40). Spinoza calls the understanding arising through the third kind of knowledge, as knowing under a species of eternity, an understanding which depends on mind, as on a formal cause, insofar as mind itself is eternal (Spinoza 1996: V, P29, P31). Significantly, as the Marxist philosophers Louis Althusser and

Etienne Balibar (1970) and the libidinal materialist Gilles Deleuze (1978, 1992) have shown, this Spinozean analysis is amenable to a materialist rather than a theological interpretation⁴.

2.3 Inert and Active Knowledge

In his essay on 'The Aims of Education' Whitehead defines the aim of education as the production of 'men who produce both culture and expert knowledge in some special direction'. He further characterises expert knowledge as the 'ground to start from' and culture as what will lead them 'as deep as philosophy and as high as art'.

The major target of his opprobrium is what he calls 'inert ideas,' which he defines as those 'that are merely received into the mind without being utilised, or tested, or thrown into fresh combination'. He declares that education with inert ideas 'is not only useless but above all harmful—*curruptio optimi, pessima*,' which, he suggests in less patriarchal terms, is the reason 'why uneducated clever women, who have seen much of the world, are in middle life so much the most cultured part of the community'.

To avoid inert ideas, Whitehead recommends that we, 'Do not teach too many subjects,' and cautions that 'What you teach, teach thoroughly.' Inertness obtains when small parts of a large number of subjects are passively absorbed as 'disconnected ideas', without illumination by 'sparks of vitality', and without being leavened by the 'joy of discovery'. He deploys the term 'understanding' in the sense applied in the French saying, 'To understand all is to forgive all.' Above all, understanding should be useful, and should be directed at 'the insistent present', the holy ground which contains all there is.

Understanding comes through utilization, which in turn can come about through an appreciation of the importance of the idea (in this light, Whitehead suggests that proof is not essential but may be introduced later for completeness). Theoretical expositions should be short but thorough, and 'not muddled up with the practice'. Proving should be kept separate from utilizing but what is utilised should be proved and what is proved should be utilised. For example, algebraic solutions to quadratic equations may be too specialised for some, and unless they fit into a connected curriculum there is no reason to teach them.

One thing to avoid is the conception of the mind as an 'instrument' that requires 'sharpening'. The mind is perpetually responsive and receptive, never passive, 'you cannot postpone its life until you have sharpened it'! The apprehension of ideas is a patient process, with no 'royal road' to understanding. The issue is less mistaking the wood for the trees than one of making the pupil see the wood by means of the trees. There is only one subject matter in the modern curriculum, that being 'Life in all its manifestations.' Moreover, 'you cannot put life into any schedule of general education unless you succeed in exhibiting its relation to some essential characteristic of all intelligent or emotional perception.'

Rather than teach abstract functional equations for their own sake we are better off in treating the fluxes of history. Moreover, 'one train of thought will not suit all groups of children,' for example, Whitehead suggested that 'artisan children will want something more concrete' and, in a sense, swifter than what he has explicated in his essay. Nor should we give equal weight to all aspects of the curriculum, instead, allowing students to choose their own specialisms. In Geometry, all the 'great, fundamental ideas' should be taught, but they should be supported by visual figures and practice in geometrical drawing. Moreover, the best education is often gained from the simplest apparatus (e.g. making a map of the local district for both history and geography).

⁴ Althusser and Balibar interpret Spinoza's notion of the third kind of knowledge, or the synchronic (i.e. "eternity in Spinoza's sense"), in relation to Marx's notion of the "concrete-real", in other words they conceive it to be the "adequate knowledge of a complex object by the adequate knowledge of its complexity" (Althusser and Balibar, 1970: 107). For a whole generation of Marxist scholars, this Spinozan provides an alternative to the dubious practice of "inverting" the Hegel dialectic!

Whitehead defines style as the 'last acquirement of an educated mind'. It is the 'fashioning of power, the restraining of power.' With style, the 'effect of your activity is calculable' with respect to its aims. However, it is always the 'product of specialist study, the peculiar contribution of specialism to culture.'

3. Knowledge-Based Regional Development

This section of the paper provides a means for investigating the applicability and pertinence of Whitehead's ideas in regard to a topical area of debate in economic geography, social theory and regional science: the literature on the regional 'Knowledge-Base'. Many proponents of regional development draw on Michael Polanyi's distinction between tacit and codified knowledge. Polanyi vehemently opposed any Laplacian form of reductionism that would reduce the social sciences to the psychological, the psychological to the biological, and the biological to the physical sciences. Instead, he argued that each preceding 'ontological layer' determined boundary conditions for the layers that succeed it. However, as we ascend towards the social we must confront higher levels of ethical responsibility and meaning. In the same way that vocabulary implies syntax, which in turn implies semantics, so does sensory-motor function imply intelligence, which in turn implies responsible choice.

Polanyi's analysis of tacit inference conforms to this broader anti-Laplacian frame. Tacit inference functions by isolating a unified object (through what he calls focal awareness) against a background (by what Polanyi calls subsidiary awareness, which is the product of a diffuse and almost subliminal perception). The resulting process of inference is an irreversible process creating new qualities that are not explicitly present amongst the subsidiary elements.

As an example Polanyi introduces the binocular perception of depth. Under the operation of tacit inference, the known and perceived whole is always greater than the parts. When the process is reversed. In the case of binocular vision, we fall back on separate images losing most of the cues relating to the perception of distance. Polanyi argued that although tacit inference played an important role in sporting activities, it was no less important in higher intellectual functions such as playing chess or even in pure mathematical analysis.

For Polanyi, the implications of these conceptions lead him to oppose administrative control over scientific research. He viewed the transmission of largely tacit knowledge as an apprenticeship in which younger researchers acquire insight through a process of learning-by-doing. Moreover, personal commitment was necessary for groups of scientists to continue doggedly along a specific research trajectory even when evidence goes against them. Thus, he argued that financial support for scientific research should be determined by the scientific community itself, rather than by bureaucratic planners or via cost-benefit analysts.

Geographers have used Polanyi's conceptions of tacit and codified knowledge to explain the importance of proximity effects in regional development (Teece, et al., 2000). Unless it can be transformed into a codifiable form tacit knowledge can only be transferred through 'being there' in a face-to-face encounter with those who already possess it. This simple insight is drawn upon to explain the geographical clustering of firms. Diffusion of tacit knowledge can be amplified by various forms of increasing return, network externalities, and processes of collaborative learning, on the part of co-workers, customers, and suppliers. This material is congruent with related research on clusters, strategic alliances, and networks (Richardson, 1972; Camagni, 1991)

The burgeoning literature on the knowledge-base is motivated by the conviction that the Polanyian distinction between tacit and codified knowledge affords too narrow a base on which to construct a comprehensive theory of sustainable competitive advantage. Thus, Gertler has developed an alternative classification scheme relating the different kinds of knowledge to the characteristics or 'affinities' of various industrial sectors, institutional

arrangements (e.g. firm specific routines, corporate culture), and individual participants (i.e. language, education, experience). He argues that the pattern and complexion of institutions can vary by nation due to the presence of different ‘varieties of capitalism’ (e.g. bank-based or equity-based systems of corporate governance), and on a regional level due to the qualities of different ‘learning regions’ (e.g. differences in the shared milieu of norms, conventions, routines, protocols). The policy implications are that governments can influence both the national system of governance and the characteristics of regions and their populations to promote sustainable competitive advantage and economic growth. This is why it is important for researchers to develop meaningful ways of categorizing knowledge.

Gertler draw on Immanuel Kant’s distinction between analytic knowledge (which is viewed as deductive in nature) and Synthetic knowledge (which is conceived to be more inductive in nature). In addition, a third category—symbolic knowledge—is introduced (which is seen to depend more on semiotic considerations of aesthetic sensibility and creativity). Gertler has increasingly distanced himself from his early research into the successful uptake of Advanced Manufacturing Technologies, which placed more emphasis on national differences in work practices and training cultures rather than ‘embeddedness’, or the institutional milieu of norms, conventions, and routines (Gertler, 1995; Beccatini, 1990).

This shift is reflected in a notable change of terminology. The following table is taken from a series of overheads prepared for a talk on ‘Buzz without Being There,’ subtitled ‘Communities of Practice’. Gertler distinguishes between geographical proximity and relational proximity, arguing that relational proximity can be achieved at a distance. In his new taxonomy, reproduced below, Gertler examines the relationship between the different characteristics of each knowledge-type and the respective forms of understanding, modes of transmission, and associated ‘locational’ attributes of meaning. For each category, representative industries are also proposed.

Analytical	Synthetic	Symbolic
Know why: developing new knowledge about natural systems by simplifying scientific laws	Know how: applying or combining existing knowledge	Know who: Creating meaning, aesthetic qualities, affects
Deductive scientific knowledge, models	Inductive problem-solving, customised	Creative process
Collaboration within and between research units	Interactive learning with customers & suppliers	Learning-by-doing; studio, project teams
Strong codified knowledge, abstract content	Partially codified knowledge context specific	Strong semantic knowledge, highly context specific
Meaning relatively constant by location	Meaning varies substantially by location	Meaning highly variable by location
Pharmaceutical R&D	Mechanical Engineering	Advertising

In Communities of practice, ‘relational proximity’ and new modes of ‘deterritorialised closeness’ are achieved through collective investments in ‘symbolic capital’ in the form of community routines and practices. These practices enable members to identify and solve work-related problems (Gertler, 2003: 86-7). ‘Learning Regions’ develop ‘institutional endowments’, local assets and capabilities that underpin proximity effects and promote the clustering of firms (Gertler, 2003: 84-5). At a micro-scale, ‘knowledge enablers’ help to develop the social context for localised production through recruitment, ‘story-telling’, and

the dissemination of knowledge within multi-local and multi-divisional firms (Gertler, 2003: 88).

Gertler's more recent work is now replete with the new jargon of 'pipelines', 'buzz', and strategies to support 'creative cities' (Gertler, 2003, 2006). 'Buzz' derives from the information and communication ecology created by face-to-face contacts, co-presence and the co-location of people and firms within the same industry and place or region (Batheldt et al., 2004: 38). These flows are both spontaneous and fluid, but can either be targeted or accidental. 'Pipelines' enable regions to bridge 'structural holes' by augmenting absorptive capacity and can prevent stagnation or the 'over-embeddedness' of a given institutional 'milieu'. They enable information flows to be strictly monitored and controlled also supporting access to major markets, technologies, and pools of skill. Moreover, although their effectiveness is strongly influenced by 'degrees of trust' and levels of uncertainty, they must be constructed through systematic processes of accumulation (Batheldt et al., 2004: 41-2). Policy emphasis is now placed on policies to promote community renewal, reduce social exclusion, build confidence in creative talent, and create future cultural consumers, including through public education and the provision of public infrastructure and creative spaces.

4. A Critical Response

Contributors to the knowledge-base literature are typically advocates of the 'New Regionalism'. According to this doctrine, the competitive advantage and prosperity of regions can supposedly be promoted in isolation from that of the nation as a whole through a 'neo-Mercantilist' reliance on global markets and foreign direct investment. A number of critics have raised concerns about this paradigm of regional development, primarily due to its neglect of effective demand constraints that apply on both national and international scales. Although limits on space preclude a detailed elaboration of their arguments, these issues have been addressed at some length in Mitchell and Juniper (2007, 2005).

However, beyond this general concern, the specific inadequacies of Gertler's classification scheme must be addressed. Kant's distinction between analytic and synthetic judgments is one that can be found both in medieval theology and Leibniz's subsequent philosophy of logic. Analytical judgments are those for which the connection of the predicate with the subject is 'cogitated through identity' (e.g. all bodies are extended) while synthetic judgments are those 'cogitated without identity' (e.g. all bodies are heavy). Similarly, while *a priori* knowledge is independent of and conditions the nature of experience, *a posteriori* knowledge is dependent on experience.

The original purpose of Kant's distinction—one that is now questioned by many analytical philosophers—was to emphasise the role of what Kant called *a priori* synthetic forms in conditioning the very possibility of knowledge⁵. Moreover, both analytic and synthetic forms of knowledge are inflected by and ground the semiotic aspects of what Gertler calls symbolic knowledge. Whitehead's inert knowledge is the outcome of an isolation of the deductive from the inductive, which should raise doubts about Gertler's taxonomy. From a more prosaic perspective, while the pharmaceutical and the automotive sectors may resort to differing levels of industrial R&D, varying combinations of pure, basic and applied research, and different constellations of new product development and continuous improvement, placing them on different poles of a deductive-analytic versus inductive-synthetic continuum would seem far too simplistic. And despite the semantic bias of the advertising sector, here too, specific images, video sequences, messages, survey instruments, and questionnaires must be produced and commercially applied.

⁵ For Kant, the process of synthesis acts as a bridge between the pure sensibilities of time and space, and the logical categories of quantity (unity, plurality, totality), quality (reality, negation, limitation), relation (subsistence, causality, community) and modality (possibility, existence, and necessity). And the general form in which undetermined existence is determinable by the 'I think' is that of time. In this regard, *both* the deductive and inductive forms of knowledge are conditioned by what Kant calls the *a priori* synthetic.

Whitehead himself, rejects the Kantian penchant for attending to, and thinking the limit in relation to the knowing subject, along with both the phenomenological orientation towards lived experience and human intentionality, and hermeneutic investigations of interpretative acts. Instead, Whitehead attends to the world as subject, to the world as what keeps us busy, to the world in its determinacy and indeterminacy. However, Latour (2005: 229-30) observes that Whitehead's concern with modes of perception does not direct us to the perceiving mind, but to a point of view or locus, to what is grasped by scientific endeavor within the frame of the panorama that is being embraced.

Strong resonances can be detected in Whitehead and Polanyi's respective distinctions between tacit and codified knowledge and visual and visceral modes of perception. Each thinker draws on his preferred distinction to mount a critique of Humean skepticism, while simultaneously questioning the privilege accorded to consciousness on the basis of an embodied mode of causal and temporal understanding. For each it is necessary to transcend clarity and order to achieve progress, experience excitement, and deal with the unforeseen.

Polanyi's notion of tacitness remains crucial for an understanding of competitive advantage and inter-firm relations. In terms of the former tacitness operates as an untraded source of uniqueness and a barrier to replication by rival firms, due to the requirement for face-to-face engagement. For the latter, it explains the need for strong bridges between the sectors of science and industry, and cooperative interactions between users and producers of technology.

One of the crucial weaknesses of Gertler's analysis is his neglect of the issue of power relations.⁶ Nevertheless, drawing on the affinities previously highlighted between Whitehead's process philosophy and Spinoza's doctrine of the three kinds of knowledge, we can suggest an alternative taxonomy that no longer sweeps issues of power under the carpet. Deleuze (1978) points out that under the operation of the second or third kind of knowledge, adequate perceptions come from inside rather than outside, because one is raised to another aspect of essence now conceived as expressing itself in a relation through the common notions. To elucidate Spinoza's discourse on knowledge, Deleuze draws on the example of someone's perceptions of the sun's rays on their skin. In accordance with the second kind of knowledge, Deleuze suggests that the knower acquires a practical comprehension of the sun and can compose the relation of her body with such and such a relation of the sun. She is not far from being able to say, 'the sun, I am something of it.'

Ideas of the third kind belong to essence insofar as essence is in itself and for itself a degree of power. Moreover, affections are affections of essence in the form of an 'autoaffection'. Under the third kind of knowledge Deleuze (1978) suggests that the knower's relation to the sun is 'mad in the first degree'. We now have a solar autoaffection, a mystique of the sun at the level of the modes, while preserving intrinsic distinction, such that 'the rays by which the sun affects me are the rays by which I affect myself!' The efficacy of the third kind of knowledge is grounded in the generative capacity of the infinite intellect of God or Nature who produces with the same necessity by which she understands herself.

Within a state constituted on the basis of reason, Spinoza contends that the composition of men would be determined by the common notions and the active feelings of freedom, generosity, and firmness that follow from them. In such a state, the law would operate as an eternal truth and guide for the full development of the power of each individual (Deleuze, 1988a: 107). While priests and tyrants rule through fear and sadness a democratic state engenders joy and concert.

⁶ In Gertler (2003), for example, the only reference to power relations appears in footnote 13 where Gertler commends the work of Amin and Allen.

5. Conclusion

Without doubt, the recent revival of interest in Whitehead's process philosophy on the part of social theorists, sociologists of science, and continental philosophers has been stimulated by recognition of shared concerns and shared problems. These concerns include a desire to overcome the bifurcation between objective knowledge of a desiccated, abstracted world and the vividness of lived experience, and a desire to provide a robust ontological ground for scientific and educational practice.

The philosophies of Polanyi and Whitehead are of enduring value. Their thinking, unlike that of Gertler, is imbued with a notable political dimension, respectively of a liberal and implicitly radical democratic persuasion. In comparison, the managerial and 'New Regionalist' orientation of the knowledge-base literature is banal, bland, and lacking in insight. It would seem that there is significant scope for further research along Whiteheadian lines. Latour's conception of the odour kits designed for the training of 'noses' captures both the semiotic *and* the ontological dimensions of what Whitehead is trying to convey in his writings. Whitehead highlights the fact that an interpretation of what is revealed by one mode of perception in terms of the other mode is an important source of error and misconception. This crucial insight—one deserving of much more detailed attention than can be afforded here—seems to be entirely lacking in much of the burgeoning discourse on educational psychology. His insights into educational failure, as expressed in the production of inert knowledge and disconnected ideas, could be fruitfully combined with approaches based on the analysis of the labour-process. However, these themes must provide the ballast for future research, both theoretical and applied.

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