The Structure of Scientific knowledge

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Abstract

This paper makes a theoretical critique of the concept of scientific knowledge. The classical conception of scientific knowledge has been discussed and analyzed in the first section. In the second section, emerging conception of the scientific knowledge has been explored. The author hopes to show on the basis of veritable critique from different philosophers of science as well as scientist (Kuhn, 1967, Polanyi, 1983, Prigogine, 1984), that the structure of scientific knowledge, the way it is interpreted and legitimized, is not only shaped by the personal and cultural orientations of its practitioners but also by the larger cultural context, in which it is carried out.
Key words: structure, scientific knowledge, classical, tacit and dissipative structures.

1. Classical Conception of Scientific Knowledge

Liberty, fraternity and equality, were the catchwords which inspired the dawn of the “Reign of Man” in 1789 and unleashed the profound creative energy which have since transformed our world to an unrecognizable extent. Man’s ideas of the self and the world around him were completely metamorphosised. The “temple of reason” was resurrected with a political revolution in France and consequently a new form of social and philosophical life took shape, in fact a new power of mind was realized by man, the power of science. Subsequently, the natural philosophy which emerged, questioned the Medieval and Renaissance conceptual legitimacy of notions such as authority, self-image, knowledge and reality. The dissolution of old structure of perception was replaced by new method of understanding the world and its constituents. This new method of knowing was galvanized by Galileo, Kepler and Newton. The characteristic features of this method were abstraction (rational constructions), universality (generalization), observation (experimentation) and domination (control) over nature (natural world) by man.

This was the time from which, onward, civilization entered into democratic consciousness of itself and its constituents (man and culture), and autocratic notions of truth and knowledge were abandoned forever. The logical consequence of this tremendous cosmological shift, though, appears to be simple yet contains in it profound capability to influence the

traditional perceptual structures and value systems of human societies.
This new found capability to understand, observe and question the nature, structure and growth of the world, universe and it's manifestations, in a non-religious way, and then formulate rational explanations/interpretations of human existence and physical reality, constitutes the core of this classical method of knowing the world.
The enthusiasm which bewitched every thinking being of 18th & 19th century Europe was the subtle understanding of the near perfect rationality of the behaviour of nature, universe and the human society. This sense of profundity was the product of the power of this new method of knowing, the infallible belief in the systematic palpability and universal validity of the natural world (and the laws thus formulated to describe its various aspects), consolidated with the conceptual tools of observation, abstraction and experimentation. The scheme, which thus emerged, perceived reality/nature as an object, an automaton to be analyzed in bits and pieces, to find out its eventual universal structure. It was operated upon, slashed, atomicised and reduced to minimum physical and mathematical terms.
The knowledge, or more appropriately scientific knowledge which then crystallized, became a kind of apparent truth, self-contained and self-poised, which consistently, and at times harshly, separated being from becoming, man from nature, progress from values and matter from mind.
The grammar of this new methodology was thus; that the universe (and human societies included) was viewed as a big automaton, a machine, behaving in a deterministic timeless and ordered fashion.
Change, process, growth and time-oriented activity were banned in the new found crystal palace of physics and mathematics. Thus, what, Prigogine and Stengers term as the "mechanistic world-view",[1] triumphed over other forms of knowledge and conceptualizations of reality in the new cosmology of things. This triumph of mechanistic world-view was necessitated and supported by the rise of factory civilization. Alvin Toffler has pointedly underscored the historic coincidence between the rise of factory civilization and the triumph of mechanical weltanschauung, in his foreword to Order out of Chaos. He says "Mechanistic view coincided with the rise of factory civilization, and divine dice-shooting seems hardly enough to account for the fact that the age of the machine enthusiastically embraced scientific theories that picture the entire universe as a machine".[2]
Henceforth, the succeeding generations of scientists focused their energies to discover new universal "laws of nature" to be revered with awe and enforced through the selective manipulation of scientific institutions as a sacred creed, not to be challenged and questioned, to the exclusion of all other modes of scientific inquiries from this privileged status. So much so that the theoretical constructions of physics and mathematics

became the criterion of scientific knowledge.[3] This attitude of selective manipulation of scientific knowledge and its related fields of inquiries was even reflected to minute levels of study. For example, the studies of certain type of phenomena and facts were suppressed and discouraged on the behest of prevalent “scientific fashions” in the institutions, and scientists (who is a kind of seeker after new facts, new phenomena, new truths), were reluctant to indulge into such studies for fear of being dubbed as backward.[4] So it seems that the values which motivated the quest for an empirical-rational construction of the natural world were at times negated by the autocratic ambitions of the scientific institutions.

Science (and knowledge produced by its technique) is a social activity, rooted in the historical experience of mankind, inspired and influenced by the peculiar cosmological-philosophical convictions and emotional idiosyncrasies of individuals who subscribe to its methodology, and larger social context in which this activity is going on. Be it Galileo and Kepler, Newton or Einstein, Heisenberg and Boltzman, their quest for a reasonable description of nature and reality reflects their own prejudices, choices and the prejudices and choices of their age, in which they happen to find themselves situated and tormented. Their interpretations of the structure of reality are constrained by their times and traditions; in short a vision of nature underlies their conceptual frameworks.[5]

Newtonian world-view of science also presented “a vision of nature that would be universal, deterministic and objective in as much as it contains no reference to the observer, complete in as much as it obtains a level of description that escapes the clutches of time.”[6] This vision of nature/reality, in which nature appears to be a silent and mutant version of an ancient city, man is a spectator, an alienated being, surrounded by objects and tools which, he has to master at any cost (even at the cost of his soul). Lonely, dehumanized and trapped in his quest for simplicity, objectivity, man experienced himself, as a Kafkan character, the consequence of his double alienation, from his soul and from nature.[7] This sense of alienation and dichotomy resulted from an over– confidence in the healing power of scientific knowledge and technological advancement, which was, intact, not a pure revelation of human mind but an equally treacherous path to self-knowledge, like of which man has traversed earlier in history. The dichotomised consciousness became so entrenched that, Prigogine has to remark in a critical tone,

For ancients, nature was a source of wisdom. Medieval nature spoke of God. In modern times nature has been so silent that Kant considered that science and wisdom, science and truth, ought to be completely separated. We have been with this dichotomy for the past two centuries. [8]

2. Tacit Component, Dissipative Structures and Anything Goes?[9]

"We now understand that we live in a pluralistic world"[10] and "for humans, reality is embedded in the flow of time."[11] Similarly any attempt to describe scientific knowledge in an impersonal and objective way, which is devoid of tacit component of scientist's participation and emotional involvement in the act of knowing is barren and doomed to wither away.[12] Laplacean ideal of scientific knowledge and the "philosophic movement guided by aspirations of scientific severity has come to threaten the position of science itself, a passion for achieving absolutely impersonal knowledge presents us with a picture of the universe in which we ourselves are absent".[13] The varied studies in what Prigogine terms as the "science of complexity"[14] has exposed the insufficiency of traditional epistemological assumptions of Newtonian conception of knowledge, and which is characteristically reflected in the "Laplacean delusion"[15] Quantum mechanics, biological sciences and thermodynamics have produced new conceptual orders vis-à-vis man's understanding of diverse evolving languages, at his disposal for the description of the structure of physical reality as well as living world. "No single theoretical language can exhaust the physical contents of a system. Various possible languages and points of view about the system may be complementary."[16] Classical world of timelessness, order and reversibility, which is described by an "objective observer" does not hold ground anymore. "The choice once makes about what he observes makes an irretrievable difference in what he finds. The observer is elevated from "observer'" to "participator". What philosophy suggested in times past, the central features of quantum mechanics tells us today with an impressive force. In some strange sense this is a participatory universe.[17] The classical vision of nature "is undergoing a radical change toward the multiple, the temporal, and the complex"[18] and in addition to deterministic processes, there must be an element of possibility involved in some basic processes, such as, for example, biological evolution or the evolution of human cultures.[19] Classificatory and hierarchical theoretical language of classical world is now replaced and at times enriched by new set of concepts, describing more accurately our changing conceptualizations of reality. New concepts such as fluctuations, creativity, irreversible processes, active self-organization of matter, commitment, participation in the act of knowing, plurality of perspectives, are extensively employed by contemporary scientists and philosophers to describe the structure of scientific knowledge. It seems now that man is no more a passive subject receiving only sensory data of an all-powerful universal reality and organizing them into an "economy of thought"[20] into descriptive tools

and in the service of some awesome external reality, rather, his act of knowing is “dwelling in and breaking out”[21] of his experience of reality, a kind of active participation, facilitated by these conceptual tools, an engagement in the form of a “dialogue with nature”[22] and not its enslavement or being enslaved; in short, he is a “macroscopic being embedded in this physical world.[23]

The contemporary advances in the methodologies to understand the structure of scientific knowledge are as diversely constituted as the varied temperaments of their respective designers, reflecting the multiplicity of descriptive languages and the inherent complexity of conceptual explication. This is because they are motivated by different kind of intellectual passions. Similar is the case with scientist who is engaged in the production of scientific knowledge in the first place. Ranging from Popper’s conjectures and refutations (falsificationism) to Lakatos methodology of research programs, to Feyerabend’s epistemological anarchism to Polanyi’s personal knowledge to Prigogine’s science of complexity, all of these demonstrate the theoretical diversity vis-à-vis, the “wealth of reality”[24] which each one of them is trying to describe in his own style and grammar.

Knowledge (and the scientific knowledge, whose structure they are describing) is no more a pure activity but a human activity which reflects in its development the power and limitations of human condition. Furthermore, it is also doubtful whether a universalistic and singular status could be accorded to scientific knowledge in the history of human culture.[25] However, two aspects emerge quite clearly from these diverse methodologies; firstly, if one follows a certain type of methodological rule for understanding the nature, structure and growth of scientific knowledge, he is bound to end up with barren analysis. Secondly, man is involved in this process of acquiring new understanding, if knowing the structure of nature and reality. In fact, this endeavour is not impersonal and objective, as some would like to see it, rather it is a voyage of intimate encounters with reality, of “intellectual passion”[26] of “unjustified (and unjustifiable) anticipations”[27] of “irreducible plurality of perspectives on the same reality”[28] (or perhaps a different reality, a new reality), of “anything goes.”[29]

Therefore, it is evident that the sort of knowledge, which the philosopher of science is trying to describe with his conceptual tools cannot be confined within a single methodological language. Simultaneously, the sort of knowledge, which is produced by “skills”[30] called scientific, appears to be of one of the models of communicating with reality and displays a structural-logical quality different from other modes of knowledge production conditions of man. Furthermore this mode of knowledge production may have different tactical variations within its functional

fields of inquiry, motivated by strategies of differing philosophical and moral overtones of its own practitioners (scientists). Then, how can a methodologist generalize scientific knowledge as a paradigm case for all forms of human knowledge? How can he plead the case of "scientific rationality" as a model of human rationality and reduce the multiplicity of other modes of human inquiry such as arts, religious experience and myth, which are required to follow methodological constructions and rules of a rationality, whose nature, structure and sources are entirely different from these human activities? Therefore, one has to consider, if one has to have a satisfactory answer to above questions, the actual development of science in the human societies, its grammar, culture and history. Only then a true sense of its claims and raison d etre to which it is demanding such a forceful attention can be ascertained. This becomes more obvious, when one looks at the theoretical/conceptual apparatus employed by the scientist in the description of physical reality, and which is used for the production of scientific knowledge.

It does not happen in ivory-towers, the formulation of hypothesis, construction of theories, tools of observation, experimental devices, testing and acceptance of concepts, and discoveries of new laws and phenomena are governed by the prevalent rules of the game, by doing "normal science,"[31] by prejudices, by propaganda, by tactics and by intimation. This situation is further constrained and escalated by the profound cosmological as well as ideological idiosyncrasies of its practitioners.[32] All those conditions collectively influence the growth and definition of scientific knowledge. In short, one has to research the historical grammar of scientific knowledge in action, for understanding its nature and structure, as practiced by its professors and not by the terms, rules of logician or methodologist.[33] Therefore, any methodology of scientific knowledge which overlooks the cultural-historical context of or what Feyerabend aptly terms, as the "cosmology" underlying the scientists theoretical constructions, and conversely imposing rules for doing good science or laying down criteria for what is scientific and what is not, losses touch with the culture of scientist; and the larger culture of humanity in which he is situated. It reduces science "the great system of utterances which try to evoke and impose correct mode of feelings"[34] on the scientist's mind and his activity (scientific inquiry) to mere logic chopping, and conceptual purity, which is meaningless and devoid of social significance. Described in strict rules (and rationalities) scientific knowledge, assumes a confrontational posture towards other modes of knowledge acquisition or else denigrade them. This is what has created deep cleavages in the cultural life of modern man. Why? The answer lies in technology, which is a facade of modern scientific knowledge and has become so powerful a business in the hands of its practitioners and

the institutions which support the entire enterprise in the name of R&D. That is why Feyerabend, in his harsh polemical style dub this professional business class of scientists as “human ants who excel in the solution of tiny problems but who cannot make sense of anything transcending their domain of competence”.[35] Simultaneously, this seems pertinent to remark that the teaching of scientific theories as a factual cosmology of the time, not to be questioned, challenged or replaced by other (different) cosmologies (which possesses its own rationality & history) and its enforcement by powerful state apparatus, media and popular propaganda, constitute a medieval attitude of blind following of an infallible authority (which is perhaps vice versa). This attitude is to be overthrown if scientific knowledge has to become a cherished asset, in addition to other domains of humanity’s culture. Liberation of human society from this business-like and infallible attitude of science and scientist, philosophy must come forward to create a sense of commitment and participation in scientist’s view of the world, so as to facilitate a humanistic growth of scientific knowledge.

From Newton to Prigogine, science (and scientific knowledge) has travelled a long and treacherous path to man’s self-knowledge and discovery of the languages which universe speaks, and is some what similar to Mao–Tse–Tung’s political Long March in 1930s. The classical notions of the world have been transformed altogether into new conceptual frameworks. A universe which was a symbol of peaceful automaton, timeless, orderly, obeying mathematical laws, now appears to be, after basic discoveries in quantum mechanics, thermodynamics and bio-sciences, in a state of flux, multiplicity, complexity and temporality, trapped in fluctuations, disturbances, disequilibrium and time-oriented activity. Time creates us and the new structures of cosmos. It is more than a clock-work type of reality, static and determined. The role of passions, emotions and participation in the act of scientific discovery has now firmly been established. “A scientific theory is akin to a work of art”[36]

Scientific knowledge is no more superior to other modes of knowledge acquisition rather it should complement other domains of human experience such as myth and religious experience. It is “one of the many instruments man has invented to cope with his surroundings”[37] and consequently not infallible. Dichotomic consciousness of 18th & 19th century scientific world– view has been replaced by a sense of being part and parcel of this world and its eventual destiny. This feeling of involvement in the life of cosmos was intuitively captured by Mir Taqi Mir, a classical Urdu poet of the 18th century Mughal India in one of his couplet. He goes on to say:

Breathe in slowly, this mirror-like cosmos
Is a work delicate and subtle.

Notes and References

[1] Ilya Prigogine & Isabelle Stengers, Order out of Chaos (William Heinemann Ltd. London 1984), pp.l-86.
[2] Ibid, Alvin Toffler, Foreword, pp. xiii.
[3] Cf. Ilyas Prigogine & Isabella Stengers pp. 79-99, Chapter-III, which is significantly captioned as “Two cultures”, which illustrate the historical development of “Mechanistic” “World-view” and it’s rejection of other modes of inquiries and their claims to be scientific.
[4] Cf. Michael Polanyi writes in his Personal knowledge (Routledge and Kegan Paul, reprint 1983), p. 138, “But there is unfortunately no rule, by which to avoid the risk of occasionally disregarding thereby the evidence which conflicts (or seems to conflict) with the current teaching of science. During the 18th century the French Academy of Science stubbornly denied the evidence for the fall of meteorites which seemed massively obvious to everybody else Ibid.; see also footnote to p. 138.
[5] Cf. Paul Feyerabend, Against Method (Verso books, London, 1986, 6th Edition), especially pp. 299, 301 & 302 in which he has dealt beautifully about the politics of scientific knowledge, tyrannies of scientific institutions, selfishness of individual practitioners of science, and taboo reactions very similar to taboos reactions in primitives, evoked when basic ideas are challenged.
[6] Ibid., Ilya Prigogine & Isabelle Stengers p. 213.
[7] This would not be out of context to point out various types of philosophical responses to this feeling of alienation and dehumanization created by science and technology. For example, M. Heidegger and his guest to an ‘authentic being’, J.P. Sartre, his stress an choice, will and Albert Camus, his concept of commitment, active resistance, and rebellion to overcome this abysmal alienation of man. And several other forms of ‘Existentialism’ ranging from Kierkegaard, Karl Jaspers & Paul Tillich etc. All these philosophies in one way or other reject the rationalism, domination and mechanization of man’s power of freedom, choice, commitment and participation in the act of knowing and changing the world and his destiny.
[8] Ibid., Ilya Prigogine & Isabelle Stengers, p. 99.
[9] Cf. Michael Polanyi p. 67, Ilya Prigogine & Isabelle Stengers, and Paul Feyerabend, pp;99.
[10] Ibid., Ilya Prigogine & Isabelle Stengers, pp; xxvii

[11] Ibid., p. xxix.
[12] Cf. see Michael Polanyi, his illumination discussion on the significance of intellectual passions and their role in the act of knowing and scientific creativity, pp. 142-174 & 184-202.
[13] Ibid., Michael Polanyi pp; 142.
[14] Ibid., pp; 131 especially chapters V, VI & IX, Ilya Prigogine & Isabelle Stengers.
[15] Ibid., Michael Polanyi, p. 141.
[16] Ibid., Ilya Prigogine & Isabelle Stengers p. 225.
[17] Quoted from; J.A. Wheeler's article 'Genesis & Observership in University of Ontario's series in philosophy o£ science. Butt. R and Hintikka J. Eds (Boston, Mar. 1977).
[18] Ibid., Ilya Prigoglne & Isabelle Stengers, p. xxvii.
[19] Ibid., p. xxvii, ff.
[20] Ibid., Ernst mach quoted in Ilya Prigoglne & Isabelle Stengers pp. 53, 54.
[21] Ibid; Personal knowledge, by Michael Polanyl p. 195.
[22] Ibid., Ilya Prigoglne & Isabelle Stengers, pp; xxvvii, title of the preface to their book.
[23] Ibid., p. 301.
[24] Ibid., Ilya Prigoglne & Isabelle Stengers p. 225.
[25] Cf. Paul Feyerabend, Against Method. Verso books, London p. 296, read also with it p. 244-261, 1986) in which he discusses the difficulties entailed by the methodologist by adopting a puritanical attitude towards science and following of strict rules to describe knowledge.
[26] Ibid., Michael Polanyl, p. 132, chapter 6, part-II.
[27] Karl Popper, Conjectures and Refutations (RKP-London 1969) pp; vii, Preface.
[28] Ibid., Ilya Prigogine and Isabelle Stengers, p. 225.
[29] Ibid., Paul Feyerabend, p. 27-28
[30] Ibid., Michael Polanyl, pp. 49 & 54-59.
[31] A well known concept of Thomas Kuhn concerning the development of scientific knowledge. See, The Structure of Scientific Revolutions.1967.
[32] Cf; Paul Feyerabend, pp; 146-161 (and chapters 6 to 10) in which he has given a vivid description of Galileo's method and how it eventually overcomes Aristotelian science of his time.
[33] Ibid., Paul Feyerabend, pp. 244-261 who has made an excellent exposition of this aspect.
[34] Ibid., Michael Polanyi, p. 133.
[35] Ibid., Paul Feyerabend, p. 188
[36] Ibid., M. Polanyi, p. 184
[37] Ibid; Paul Feyerabend, pp;217