DEVELOPMENT OF MODERN SCHOOL SCIENCE - A HISTORICAL PERSPECTIVE

Rajesh Kumar
Higher Secondary Teacher
Kanhai Inter School
Nawada, Bihar

Dr. Gaurav Rao
Assistant Professor
Department of Education
C.S.J.M.University
Kanpur(U.P.)

Abstract

Science, a human approach to understand the universe, is the most prominent component of the Education system especially at school level. This paper attempts to explore the emergence of Science and Scientific method as a political construct in the 19th century and also argues its association in shaping the contemporary school science education. This paper will explore the different forms of Knowledge like Indigenous knowledge and Eurocentric Sciences, their characteristics and importance in shaping of contemporary school science. This causes the promotion of science as a coherent curriculum component and fosters the unification of scientific methods despite of important philosophical, conceptual and methodological differences between the basic scientific disciplines. By the end of Second World War, it fails to reflect the profound shifts that have taken place in the scale and nature of science. As a result, school science faces a number of challenges that have not received the appropriate scholarly attention.

Keywords: *Political construct; Eurocentric Sciences; Political construct; Philosophical, Emergence*

INTRODUCTION

Nowadays Science being an important component in the School Curricula over the globe. Such a place was not achieved without a long struggle. (Henry-1947, Jenkins-1979). And the manner in which Science has eventually been accommodated vary with different Education System. At Secondary level, Physics, Chemistry, and Biology are commonly taught as separate subjects (as in U.K.) or consequently in a "layer-cake" approach (as in U.S.) as a single subject in the combined form or General Sciences (as in India) or integrated with other disciplines, both Scientific and Non-Scientific (e.g. in Scotland, Norway). In many education systems, the compulsory study of Science within primary schooling is a more recent phenomenon, although some forms of "elementary Science" and nature study have a much longer history. (Jenkins and Swinnerton-1998).

This paper offers a brief account of the emergence of Science as a political construct and argues its importance in development of School Science Education. It promoted science as a coherent Curriculum Component and fostered an untenable but enduring notion of a unifying scientific method that continued to ignore important philosophical, conceptual, and methodological differences between the basic sciences.

ORIGIN AND DEVELOPMENT OF MODERN SCIENCE

The origin of Science go back to ancient philosophies (*e.g.* Egyptian and Greeks), while its evolution can be marked by major social transformations in Europe. Understanding this evolution helps clarifying the term Science.

The first social transformation in Europe was the renaissance movement. It eventually created the need for 17th century natural philosophers(*e.g.* Galileo, Kepler, Descartes, Wallis, Leibnitz, Huygens, Halley, and Newton) to establish a knowledge system predicted on the authority of empirical evidence, as opposed to the authority of the Church and Royalty. Natural Philosophy was imbued with the value of gaining power and dominion over nature. Other values were added as window dressing to natural philosophy in order to appease to church and royal authorities of the day. This facade of values included objectivity and a disconnection with human implications of the knowledge generated by natural philosophers. (Mendelsohn and Elkana-1981).Natural Philosophy first become a social institution in England when royal Society was founded in 1662, other countries followed. These historical events are known today as the Scientific Revolutions.

A second Social transformation stemmed from the success of natural philosophers at exercising power and dominion over nature. Their success attracted the attention of entrepreneurs who adopted the methods of natural philosophy to gain power and dominion over human productivity, in the context of various industries emerging across 18th century Britain (Mendelsohn-1976). This gave rise to the Industrial revolution and provided a new social status for technologists. These industrialists spoke of natural philosophy as the hand maiden of technology. However, the independent minded natural philosophers began to distance themselves from technologists, there by precipitating the next radical transformation in the evolution toward Modern Science (Mendelsohn and Elkana-1981).

Natural philosophers, led by Whewell, set about to revise the public image of natural of natural philosophy by portraying technologists- for example, James Watt of steam engine frame – as people whose success depended upon applying the abstract knowledge of natural philosophy . He and his colleagues succeeded in their revisionist project, and today there is a widespread belief in the erroneous notion that technology is solely “applied Science”, thereby maintaining the ancient Greek Philosophy (Ideology) that hold “pure Science” superior to practical knowledge.(Collingridge-1989).

Revising history was only one step in the 19th century's radical advancement towards modern Science. A new Social institution was required and it needed to secure a social niche in 19th century European Society. In short natural philosophy needed to be professionalized (Orange-1981).Very professionally and politically, the name Science was chosen to replace natural philosophy during the birth of the new organization in 1831, the British Association for the Advancement of Science (BAAS). Thus BAAS

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added a new meaning of Science to the English lexicon, a meaning we primarily use today. In archaic English, Science simply meant knowledge (Latin- *Scientia*). Given to its BAAS origin, Science in the Anglo-world narrowly privileges in operational meaning defined, in part , by the *Eurocentric* Science taught in Universities. The word Science was politically chosen by the founders the BAAS because they required a label set themselves apart from natural philosophers , from technologists steeped in the success of the industrial revolution, and from members of the stogy Royal Society (Macleod and Collins-1981). The BAAS also sought a privileged position from which the lobby financial support for the work of its members, and from which to establish an ideology of an emerging School Science Curriculum. Furthermore, the BAAS served as a model for the American Society of Geologists and Naturalists and the American Association for the Advancement of Science (AAAS).

The appearance of Herschel's *Preliminary Discourse on the Study of Natural Philosophy* in 1831 first ever emphasized on the importance of the scientific method and also is concerned in a general way with epistemological issues. (Whewell-1831:377). In addition, it mirrored a rapidly growing interest in the nature of scientific method which led a 'Virtual revolution in the study of the history and philosophy of Science'. (Laudan-1968:29). This rise in interest in scientific method coincided with a growth in the specialisation and professionalisation of the scientific community and prompted the establishment by erstwhile natural philosophers of specialized learned societies to promote their particular and increasing divergent interests. For example, the Geological, Astronomical, and Chemical Societies were founded in 1807,1820 and 1841 respectively and their counterparts in the U.S.A. in 1888,1899, and 1876.

The divergent specialization and fragmentation of the growing community of Science was an important issue for the British Association for the Advancement of Science (BAAS). In 1836, *Mary Somerville* in his book" *On the Connexion on the Physical Sciences"* claimed as far as these sciences were concerned, there exist ' such a bond of union , that proficiency cannot be attained in any one without knowledge of the others'.(Somerville-1836:preface). This idea of unity among the sciences remained important for political purposes. The question was how such unity could be nurtured at a time when increasing scientific specialization was bringing evident success and it was rapidly becoming impossible for a scientist to keep up to date with developments outside the specialist field. *Herschal*(1831)answered it as- 'natural philosophy is essentially united in all the departments, through all of which one spirit reigns and one method of enquiry applies.'(Herschal-1831:219)

This highest importance given to the Herschal and his illustrious predecessors *Aristole, Bacon, DesCartes, Comte , and Nietzsche* was not the Victory of Science that distinguished the 19th century but 'the Victory of Scientific Methods'(Nitzsche-1967:261). In 20th century a number of publications emphasized globally the importance of Science in education. (e.g. AAAS-1993,Committee to enquire in the

positions of Natural Sciences-1918, National Science Board-1983, Mudaliar Commission-1953,Kothari Commission-1966, I.C.S.U-2007). Even through these accounts invariably find it necessary to give considerable attention to individual scientific disciplines.

During Mid of the 19th century, the role of scientific method in presenting science as a coherent whole was reflected in the schooling of Science. Thomas Huxley (1865) urged the BAAS to use its growing political influence to publish and endorse a unanimous report that 'would……hasten the change in…….education which must sooner or later be brought about' (Huxley papers-1866; quoted in Layton-1981:193). Such a report appeared in 1867 and it argued that the case for teaching Science rested upon five distinct grounds. First- Science offered an excellent means of mental training by 'providing the best discipline in observation and collection of facts, in the combination of inductive and deductive reasoning, and in accuracy of both thought and language.' Second – the incorporation of Science within school curricula could remedy some of the defects of the ordinary school education by appealing to those on whom the usual non-scientific studies produced 'very slight effect' and by continuing a very valuable element to the education of those who showed a special aptitude for a literary culture. Third- the method and results of Science had ' so profound by affected all the philosophical thought of the age' that to be unaware of them was a 'great disadvantage'. Fourth, it was claimed that the teaching of Science could be justified on the ground that 'even a moderate acquaintance' led to 'very great pleasure' in later life, and Fifth, Science should be taught because it affected materially 'the present position and future of civilisation', i.e., because scientific knowledge was useful. This five-point rationale was underpinned by a sharp distinction between two aspects of Science Education, namely scientific information and Scientific training. This distinction has endured to the present day, although it has been expressed in different term (e.g. 'content' and 'process') and been supported by a variety of psychological and philosophical perspectives (e.g. behaviourism, positivism, constructivism,).

It was Huxley and subsequently, within the context of School Science, Henry Edward Armstrong, who gave Scientific method a particular and seminal formulation. For Huxley, Science was 'nothing but trained and organized common sense differing from the latter only as a veteran may differ from a raw recruit (Huxley-1905:45) whereas Armstrong's concerns were much more directly pedagogical than philosophical. For Armstrong, the success of science education stemmed from the application of a method which was merely 'a game', whose rules, could be learned and applied, and elaborated in *The Teaching of Scientific Method* (1903).

By the early years of the 20th century, more recent developments in both Science and Philosophy were such as to render the notion of Science as a game and as organized common sense and philosophically irrelevant. Mach and Hertz had expressed the fundamental obscurity of the apparently simple foundations of Newtonian mechanics

and Einstein's theory of relativity raised the awkward question of how Science could claim to progress by accumulating knowledge if major advances required the destruction of previously held theory. Whatever else Planck's Quantum Theory of matter might be, it could not be described, in any meaningful way, as 'common sense'. For the historian of Science , Charles Singer, " Science is a method and not a collection of facts, and this commitment to scientific method led to the development of teaching experiments and the publication of laboratory manuals, all of which claimed to help students to understand and experience what was involved in 'doing Science'.

Synchronous to this, seminal scholarly insights into the generation and validation of Scientific knowledge had not only raised important questions about the confidence that can be reasonably be placed in such knowledge but had rendered obsolete the view of Science that has sustained Science teachers for generation (Paretz-1989). Millar(1989:40) has characterized this obsolete ideology as the ' standard view of Science Education' that 'claims no specific links with any particular philosophical view of Science Method' and which, at the time of writing , he judged to be strikingly at odds with that…… current among Historians, Philosophers and Sociologists of Science. Elkana (1970) has claimed that Science teaching has trended to lag behind developments in the philosophy of Science since 1930^{s}, but Layton(1990:37) judged that the philosophy has been drawn upon selectively, raided even, to underwrite purposes that have their origins in considerations remote from philosophy's is perhaps more illuminating. Examples of such considerations include a commitment to pedagogical goals such as 'learning by discovery' and 'teaching by investigation'.

The growth of scientific knowledge during the 19th century has led to the 'fractionation of traditional disciplines into thousands of research fields' and this fractionation have been accompanied by the emergence of new disciplines based upon integration of research that has its origins in older fundamental description (Paul Hurd-1997:36). Science has also undergone a process of industrialization (Rovetz-1971) or 'technofication' as a result of the convergence of the 'Scientific friction of technology'(Bohme *et al.*-1978:278) and the 'technofication of Science', so that the distinction between Science and Technology, 'becomes blurred if, not altogether suspended (Weignar-1978:279). For Redner(1987:XI,15) contemporary Science is essentially 'techno-science' and is quite different from the European Science of the recent past……these differences are apparent in all dimensions of Scientific Research, into intellectual, Instrumental and Organisational. They also revealed in the changed relations of Science, Technology and production. The changes in the nature and organization of the Scientific enterprises can be viewed from several different philosophical and social perspectives.

MacLeod and Collins (1981) in his historical account on the foundation of BAAS placed the word Science squarely in a political arena of elite privilege. Aikenhead and Ogawa(2007) has broaden the 1831 meaning of Science in the context of 21st century by adopting a multi-Science perspectives of school Science. School Science has responded

to some of these changes in several ways, principally by refocusing curricula to give greater emphasis to the social and ethical relations of Science, Technology and Society (STS) movement.(Solomon and Aikenhead-1994). That movement has been characterized by a multiplicity of approaches that range from the Vocational, Problem centered and trans-disciplinary programmes, for example, have tended to emphasise 'the unity of the science and their associated technology in dealing with Social problems', whereas problem centered approaches raised "many of the most important STS issues but said little about how Science and Technology actually work, for good or ill."(Ziman-1994:31). Kuhn(1962) formulated a 'rational reconstruction' of Scientific progress, a reconstruction based on his own interpretation of developments in the history of Science and had emphasized on a model of scientific progress in which periods of 'normal Science' alternates with periods of 'revolutionary Science'. Normal Science is a conservative enterprise and Kuhn characterized it as 'puzzle-solving activity'. It involves 1. increasing the precision of agreement between observation and calculation based on paradigm,2. -expanding the scope of the paradigm to cover additional phenomena,3.-determining the values of universal contents,4.-formulating quantitative laws which further articulate the paradigm., and 5.- deciding which alternative way of applying the paradigm to a new area of interest is more satisfactory.

The pursuit of normal science proceeds undisturbed so long as application of paradigm satisfactorily explain the phenomenon to which it is applied. Kuhn(1962) declared that Normal Science ultimately leads only to the recognition of anomalies and crises. And these are terminated, not by deliberation and interpretation but by a relatively sudden and unstructured event like the *Gestalt* switch. Kuhn(1962) maintained that a logic of falsification is not applicable to the case of paradigm rejection. This paradigm rejection, a three-term relation involving an established paradigm, a rival paradigm, and the observational evidence, cause an emergence of a viable competing paradigm. This paradigm replacement resembles a *Gestalt* shift and cause emergence of revolutionary Science. Israel Scheffler complained that Kuhn's position on paradigm replacement reduces the history of science to a mere succession of viewpoints. Lakatos acknowledged that Kuhn was correct to emphasise continuity in science and scientists do continue to use theories in the face of evidence that seems to refute them. Popper clearly distinguished the logical relation of refutation from the methodological question of rejection.

Kuhn(1962) in *The Structure of Scientific Revolutions,* expanded the notion of *Eurocentric* Sciences from a rather narrow philosophical description to one that included a limited sociological and historical viewpoint. His concepts of paradigm, normal Science and extra ordinary Science introduced subjective human elements into Scientific ways of knowing, and thus into the fabric of Scientific knowledge itself. These concepts help to characterize the great diversity within *Eurocentric* Science.

Scholars criticised Kuhn for not clarifying his concept of paradigm sufficiently , citing

as many as 22 different definition in his First edition(1962). In response, his second edition (1970) included a post script in which he delineated legitimate multiple meaning of paradigm. First, he reiterated that a paradigm is associated with a group of Scientists who produce and validate Scientific Knowledge. " A paradigm governs, in the first instance, not a subject matter but rather a group of practitioners. Any study of paradigm – directed or paradigm – shattering research must begin by locating the responsible group or groups.(p.-180) Validation within a paradigm requires argumentation and consensus making by a group of practitioners. Second, Kuhn replaced "paradigm" with "disciplinary matrix" to clarify another meaning of paradigm. A disciplinary matrix is a "constellation of group commitments"(p.-181) This constellation comprises: a). Generalisations (*e.g.* vocabulary and equations), b). Metaphysical paradigms represented by various types of models, form, heuristic to ontological models, c). Values that guide a judgement concerning evidence and theories , as well as values that Scientists draw upon to reach a consensus, and d). examplars that serve as concrete problem – solutions for students to construct knowledge should by a community of practitioners. A third meaning of paradigm expanded Kuhn's notion of exemplar into an "assimilated…….. time-tested and group-licenced way of seeing "(p. 189). This tacit knowledge leads to his fourth point: Scientist's perceptions and interpretations depend upon Scientist's prior experiences and training (p.-198). The degree of which this tacit knowledge is shared often reflects the strength of a group's commitment to a paradigm. And lastly, Kuhn discussed the degrees of incommensurability found between different paradigms.

Kuhn demonstrated that *Eurocentric* Science does not proceed in a purely logical and impersonal way. His detractors, however accused him of undermining the epistemic authority of *Eurocentric* Science by his placing *Eurocentric* Science at the many of human emotions and intellectual facts. This criticism was countered by Bauer(1992) who pointed out that scientific consensus making most often relied upon critically analysed, empirical data (not solely upon subjective group commitments to a paradigm), and that recent history of *Eurocentric* Science "offer ample instances where science did incorporate false beliefs, sometimes under the influence of emotion and fashion"(p.62). Perhaps Kuhn's detractors were seeking a universalist descriptor of *Eurocentric* Science, rather than the narrow pluralist descriptors offered by Kuhn.

The existence of multiple paradigms, some of which may be incommensurate, illustrate the extensive diversity within *Eurocentric* Science. For this reason, we incorporate the more authentic term *Eurocentric* Sciences in this discussion.

Different paradigms often dictate different research methods. These vary so widely that it would seem foolish to think that a single, logical, five-step method –" the scientific method", could represent all *Eurocentric* Sciences. According to Rudolph (2005) this phrase was misappropriated by Science Educators from Dewey's 1910 book- *How we Think.* The ubiquitous existence of "the Scientific Method" today in school, universities,

and the media suggests that this anti-Kuhn-ian notion continues to pervade people's thinking about *Eurocentric* Sciences. Many Scientists and Scholars, including Dewey himself, have denounced the idea, and it is in their denunciations that we find greater clarity to the diversity among *Eurocentric* Sciences.

Holton (1978) in his book *The Scientific Imagination*, included several case studies to show how intuitive imagination propels *Eurocentric* Sciences forward, and how different values held by various scientists can alter the course of *Eurocentric* Sciences.

CHARACTERSTICS OF EUROCENTRIC SCIENCES

Description of *Eurocentric Sciences* from Philosophical Analysis (e.g. Margenau-1950), Historical Analysis (e.g. Mendelsohn-1976; Mendelsohn and Elkana-1981), Ideological Analysis (e.g. Smolicz and Nunan-1975), Socio-cultural analysis(e.g. Ziman-1984), Cultural Worldview Analysis (e.g.Cobern-1991) and Cross-cultural Analysis(e.g. Battiste and Handerson- 2000).

Aikenhead and Ogawa(2007) suggested following characteristics of the *Eurocentric Sciences*:-

1. Nature is knowable- *Eurocentric* Sciences presupposed that the nature is knowable. This knowledge usually comprises of generalized descriptions and mechanistic explanations. Mechanistic explanations are models or a series of cause-effect events that operate like a well ordered clock. The eradication of Mystery is a key intellectual goal of *Eurocentric* Sciences.
2. Social Goals of Scientists- The acquisition of Knowledge of nature to satisfy scientific curiosity is a reasonable psychological goal for individual scientists. From a sociological perspective, the goal becomes the acquisition of knowledge for the sole purpose of acquiring knowledge. This value has lost its relevance in contemporary society, yet it survives as an ideal in academic and school science today. Socio-cultural analyses of professionalized *Eurocentric Sciences* have uncovered diverse social goals like- prestige, social and economic progress, medical advances, corporate profits, natural security, enactment of foreign policy, globalization and competition.
3. Predictive validity- *Eurocentric Sciences* delimit the validity of their own scientific knowledge to its ability to predict, which is inextricably tied to an ability to control phenomena and events. Predictive validity can be contrasted with Content validity, represented as the mode contrasted with matter.
4. Uniformitarianism- Margenaue(1950) emphasized on the uniformitarianism of the *Eurocentric Sciences* and stated that all *Eurocentric* Scientific constructs must be applied consistently through time and space.
5. Rectilinear Time- The rectilinear time is a culture bound conception and Bolter(1984) argued that a particular technology endemic to each culture defined different concepts of time. As for example, from the clay pot (ancient Greece) to the Computer (An 20thcentury invention) through the mechanical clock(a

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14th century invention).

6. Reductionism- The *Eurocentric Sciences* tends to understand the structure and function of the whole in terms of the structure and functions of its parts. Many Scientists analytically breakdown (reduce) a complex phenomenon into simple parts, factor or variables, amenable to measurement, conceptualization and experimentation. Thus, in *Eurocentric Sciences*, the whole can be understood through the integration of these partial, fragmented, bits of knowledge.
7. Cartesian Dualism- The Cartesian Dualism bifurcates existence into two substances: Matter and Mind, the two distinct, independent and non- interacting body. The Cartesian matter is a huge machine that runs according to mechanistic laws of nature.
8. Anthropocentrism- The anthropocentrism views nature as a servant to humankind. It is sanctioned by some religions and philosophical doctrines in general, and by the *Judeo-Christian* tradition in particular. It places humans just below the heavenly angels but above animals, plants and the rest of nature. It suggests dichotomy, humankind versus nature. This European anthropocentrism is characterized by a strong universalist posture found in both uniformitarianism (above) and positivism (below).
9. Quantification- The quantification holds that materialistic reality is composed of objective mathematical relationships. As a consequence the quantification of natural phenomenon is either a requirement or at least an ideal in *Eurocentric Sciences.* In *Eurocentric Sciences,* by representation in numbers, the events and entities are objectified by stripping it of qualitative, human and spiritual attributes. "Objectivity concerns itself with quantity and not quality (Little Bear-2000, p.83) and the Subjective constructs, if not measurable, are not Scientific (Hazen-2005).
10. Realism: The Doctrine of realism claims fidelity of a true world and suggests that what, that is measurable, must exist. In other words, when scientific logic is applied to one's senses the result is a direct connection with nature. This implies that scientists describe reality independent of their act of perceiving. The resultant knowledge of nature is therefore a true reflection of things as they really are. Alternatives to realism have preoccupied Science educators for several decades, and these alternatives include various concepts of constructivism (Jenkins-2000) and the cultural image (Ogawa-1998).
11. Positivism- The nature of *Eurocentric Sciences* is strongly influenced with the ideology of the positivism , sustaining from Vienna circle to the 1960s , constructed Science free from any worldview or ideology. Positivism strongly emphasizes inductive and deductive logic applied impartially to theory- neutral observations and to strict empirical and experimental methodologies. Positivism embodies a universalist worldview in which these can only be one ideal, one norm, and one standard,- positivist's ideal, norm and standard. This positivism continues to grip school science today.

CLARIFICATION OF KNOWLEDGE

The noun knowledge does not translate easily in to most verb based indigenous languages. When translated back in to English, the corresponding Indigenous expression often comes out something like ways of living (and sometimes ways of being). Therefore, the English expression Indigenous Knowledge obviously conveys, like a Trojan Horse, a *Eurocentric* noun- oriented epistemology. In this *Eurocentric* worldviews, knowledge (as a noun) is something that can be given, accumulated banked and accessed by paper and pencil examinations. In short, knowledge within a *Eurocentric* world view is an entity separate from the Knower.

Such an epistemic concept is totally foreign to most Indigenous worldviews, and consequently, there is no equivalent word for knowledge in their indigenous language, Knowledge and Knower are intimately connected. Here, to live properly includes the goal of living in harmony (Wisdom) with nature for the sake of the community's survival (Mitchell-2005). Knowledge and Wisdom are two very different goals for ways of knowing nature. Wisdom is intimately and subjectively related to human action, "Nature provides a blue print of how to live well and all that is necessary to sustain life (Mitchell-2005: p.-39). The process of generating or learning indigenous knowledge and indigenous knowledge systems by substituting the more authentic (less *Eurocentric*) descriptive phrase indigenous ways of living in nature, a phrase that encompasses indigenous ways knowing, as well. Thus, the phrase 'Scientific knowledge' fits the context of *Eurocentric* thinking, while the phrase "ways of living in nature" fits an indigenous context.

CLARIFICATION OF INDIGENOUS PEOPLE

Indigenous peoples, according to UN perspective, are the descendents of the first people to inhibit a locality, who self- identity as members of a collective, who are recognized by other groups or by state authorities, and who wish to perpetuate their cultural distinctiveness in spite of colonial subjugation and pressures to assimilate (Battiste and Henderson-2000, pp.-61-64). They generally share a collective politic of resistance arising from commonly shared experiences of oppression, that is, " marginalization, economic servitude, and Sociocultural genocide"(Niezen-2003, p.-246).

Within the UN paradigm of indigeneity, Mc Kinley(2007) acknowledged different types of indigenous peoples, including: 1. Those whose colonial settlers/ invaders have become numerically dominant (*e.g.* Maori of Aotearo of New zeeland, First nations of Canada, quechua nation of Peru, Amei nation of Taiwan). 2. Those in third world contexts whose colonial settlers/ invaders never reached a majority but left a legacy of colonization (*e.g.* Africa and India); and 3. Those who have been displaced from the locality from which they once drew their cultural self-identity (*e.g.* immigrant Hmong communities in the USA and China, originally from Thailand). In addition, McKinley, warned "Indigeniety is a heterogeneous, complex concept" that is "contextually bound" (2007:p.-202) The qualification "contextually bound" means there is no universal

definition of indigenous. Indigenous people world wide tend to reject a universal definition for fear it might create an outsider- imposed indigenous identity, thereby colonizing them all over again (Niezen-2003).

CLARIFICATION OF INDIGENOUS WAY OF LIVING IN NATURE (INDIGENOUS KNOWLEDGE)

The Science Education research literature often identifies indigenous knowledge by such phrases as: traditional knowledge (ICSU-2002); traditional wisdom (George-1999); traditional ecological knowledge (Snively and Corsiglia-2001); native science(Cajete-2000); Aboriginal Science(Aikenhead-2006); Maori Science(McKinley-1996); and Yupiag science(Kawagley-1995), to name just a few.

The Indigenous knowledge shares the following structures as summerised by Battiste and Handerson(2000). 1).Knowledge of and belief in unseen powers in the ecosystem; 2). Knowledge that all things in the ecosystem are dependent on each other; 3). Knowledge that reality is structured according to most of the linguistic concepts by which Indigenous people describe it; 4). Knowledge that personal relationships reinforce the bond between persons, communities, and ecosystems; 5). Knowledge that sacred traditions and persons who know these traditions are responsible for teaching 'morals' and 'ethics' to practitioners, who are then given responsibility for this specialized knowledge and its dissemination; and 6). Knowledge that an extended kinship passes on teaching and social practices from generation to generation(p.42).

Aikenhead and Ogawa(2007) identified following characteristics of the Indigenous Knowledge:-

1. Monist: Loo(2005) concluded an alternative to the Cartesian dualist worldview is the monist worldview. Monism mingles *Descartes'* matter and mind, and as a result, everything in the universe is alive: animals, plants, humans, rocks, rivers, celestial bodies, natural forces etc. The aboriginal languages discuss only process- or action-oriented verbs to describe the happenings rather than objects in general.
2. Holistic- Holism can be contrasted with *Eurocentric* reductionism. In Indigenous thought, the categorization and/or separation of the knowledge and practices into science, art, religion, philosophy, etc. does not exist. Battiste and Handerson (2000) pointed out that holism leads to “harmony as a dynamic and multidimensional balancing of interrelationships in [Indigenous peoples'] ecologies. Disturbing these interrelationships creates disharmony.”(p.43)
3. Relational- Little Bear(2000) viewed, holism as “everything is animate”, and extends explanation to, if everything is animate, everything has spirit and knowledge. If everything has spirit and knowledge ; then all are like me. If all are like me, then all are my relations”(p.78) The Indigenous thoughts focusing on relationships between knowledge , people, and all of creation (the natural world as well as the spiritual) and pretends in full and responsible participation in such relationships'.(McGregor-2002 p.2). This relationship is of equal status in contrast

to the hierarchical relationship of *eurocentric* thought.

4. Mysterious- Indigenous thoughts celebrate mystery and living in harmony with mystery, in both the inner and outer spaces of existence (Ermine-1995). One aspect of the mystery is the constant motion or flux in nature. The world is constantly changing.
5. Place based- Indigenous knowledge is place based and has both power and limitation. To support this, Cajate(2000 p.77) suggested the people learn to respect the life in the places they live, and thereby to preserve and perpetuate the ecology.
6. Dynamic- Similar to Eurocentric Sciences, the Indigenous knowledge is also dynamic and survival of indigenous peoples and communities over millennia depends on their dynamic knowledge base. Kawagley(1995) observed Indigenous Ways of Living in Nature(IWLN) as not static, but evolved dynamically with new observations, new technologies, new insights and view spiritual messages.
7. Systematic empiricism- Systematic empiricism ensures a dynamic quality to IWLN, but serves indigenous peoples in much richer ways. Rather than exercising dominion and power over nature as *Eurocentric* scientists do, Indigenous people live more in harmony with nature by systematically collecting data over many generations a flux naturally occurs in their land (instead of causing flux to occur superficially as in experiments).
8. Circular Time- One alternative to *Eurocentric* science's rectilinear time is circular time(Peat-1994), a concept of time that harmonises with the myriad of cycles observed in nature. This repetitive cycles in indigenous outer space interact with cycles in inner space (Ermine-1995). This circular time, is not time travel, but a natural relationship in the web of relationships of existence.
9. Valid- In contrast of predictive validity in *Eurocentric* sciences, the indigenous knowledge shows the content validity. This content validity, was highlighted by Barnhardt and Kawagley(2005 p.9) as-" Many of the core values, beliefs, and practices associated with those worldviews have survived and are beginning to be recognized as being just as valid for today's generations as they were for generation past. The depth of indigenous knowledge rooted in the long inhabitation of a particular place offers lessons that can benefit everyone, from educator to scientist"

CLARIFICATION ON *EUROCENTRIC SCIENCES* VERSUS INDIGENOUS KNOWLEDGE

Stephens(2000) attempted to compare the *Eurocentric* Sciences and Indigenous knowledge and had formulated a table comprises of three columns, *Eurocentric Sciences,* Indigenous Knowledge, with the overlap area- the "common ground". These common Grounds suggest the similarities between both the known systems. In this comparison, the historical-political and cultural contexts are either missing or misrepresented. The exploration of colloquial domains of indigenous knowledge and *Eurocentric Sciences,* suggests some challenges. A concept of one culture may not exist in another culture, hence these different ways of knowing are not the complete knowledge systems and can not be represented as parallel mathematical sets. A further

challenge is the choice of reference point with which to describe the three ways of knowing. Descriptors such as monist, holistic, dualist, and reductionist are not culture

Table:- Indigenous Knowledge versus Eurocentric Sciences (based on Stephens-2000)

	Themes	Indigenous knowledge	Common Ground	Eurocentric Sciences
1	**Organising Principals**	• holistic • includes physical & metaphysical world linked to moral code • emphasis on practical application of skills and knowledge	• Universe is unified. • Body of knowledge stable but subject to modification	• Part to whole • Limited to evidence and explanation within physical world. • Emphasis on understanding how
2	**Habits of mind**	• trust for inherited wisdom • respect for all things	• honesty • inquisitiveness • perseverance • open-mindedness	• skepticism
3	**Skills and procedures**	• practical experimentatio n • qualitative oral record • local veri?cation • communicatio n of metaphor and story connected to life, values, and proper behavior	• empirical observations in natural settings • pattern recognition • veri?cation through repetition • inference and prediction	• tools expand scale of direct and indirect observation and measurement • hypothesis falsi?cation • quantitative written record • global veri?cation • communication of procedures, evidence and theory
4	**Knowledge**	• integrated and applied to daily living and traditional subsistence practices	• plant and an imal behavior, cycles, habitat needs, interdependence • properties of objects and materials • position and motion of objects • cycles and changes in earth and sky	• discipline-based • micro and macro theory (e.g., cell biology and physiology, atomic theory, plate tectonics, etc.) • mathematical models

SCHOOL SCIENCE

The culture of *Eurocentric* Sciences and the contexts of their Research and Developments are a far cry from the culture of Schools and the contexts of Science class rooms. The conventional culture of School Science is not conducive to teacher's rising above the Scientific method, positivism and realism (Gaskell-1992). As a result, Science Generally fails to enlighten students about the authentic *Eurocentric* Sciences that permeate their everyday lives (Lederman-2007) , and Science Teaching continues to convey what many scholars see as mythical images of realism and positivism.

Decades of research has shown that few students and adults critically understand the many human dimensions to *Eurocentric* Sciences, for example: their paradigmatic dynamics; their multiple methodologies; their culture-laden presuppositions; and their social, economic and political orientations whether or not students and adults should be conversant with such knowledge is an issue beyond the scope of this article and we simply wish to underscore the fact that School Science is not synonymous with *Eurocentric* Science, in some ways it is the authorities of *Eurocentric* Science. *Eurocentric* Sciences are fundamentally communal, but highly competitively communal.

Indigenous scholars discovered that indigenous knowledge is far more than the binary opposite of western knowledge. As a concept, Indigenous knowledge benchmarks the limitations of *Eurocentric* Theory- its methodology , evidence, and conclusions- reconceptualise the resilience and self- reliance of indigenous peoples, and underscores the importance of their own philosophies, heritage and educational processes. Indigenous knowledge fills the ethical and knowledge gaps in *Eurocentric* education, Research and scholarship(Battiste-2002,p.-5). The fallacy of binary opposites, that is, treating indigenous knowledge systems and *Eurocentric* Sciences as parallel equivalent systems, requires that we be sensitive to legitimate incommensurability. Sensitivity is heightened by seeing indigenous knowledge systems with fresh eyes, unfiltered by the polarized lenses of *Eurocentric* section. Although this creates a challenge, it is one way for individual Science educators to transform Science Education's colonial discourse. Fensham(2006:226) judged this movement that the establishment of a new subject with technology as its general title destroyed it as the bridge to more relevant content for School Science and effectively extinguished the STS movement and its considerable promise.

Now with standing this judgment, the rejection of a traditional academic approach to secondary school science and the focusing of attention on science education for citizenship that characterized the STS movement continue to influence the School Science Curriculum(Jenkins-2007:273).

CONCLUSION

Despite the ancient origin of the Science, the school science prior to UN declaration

"Science for All" and the Science and Technology Movements, fully comprises of *Eurocentric Sciences* only. The UN declaration and the STS movements tend to emphasize the multicultural perspectives of the school science education as unified knowledge with its associated technology to deal the social problems. During its development, the science, especially school science endowed narratives from the concerned society and culture. The modern school science seems to be a blend of knowledge generated throughout the world like *Eurocentric* Sciences, Indigenous knowledge, etc.

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