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Pretoria Office
134 Pretorius Street, Pretoria, 0002, South Africa. Private Bag X41, Pretoria, 0001, South Africa.
Tel: +27 12 302 2177 Fax: +27 12 302 2041

Cape Town Office
Plein Park Building, 69-83 Plein Street, Cape Town, 8001, South Africa.
Private Bag X9182, Cape Town, 8000, South Africa. Tel: +27 21 466 8000 Fax: +27 21 466 8001

Durban Office
750 Francois Road, Intuthuko Junction, Cato Manor, Durban, 4001, South Africa.
Private Bag X07, Dalbridge, 4014, South Africa. Tel: +27 31 242 5400 Fax: +27 31 242 5401

www.hsrc.ac.za

Port Elizabeth Office
44 Pickering Street, Newton Park, Port Elizabeth, 6055, South Africa.
PO Box 34115, Newton Park, 6055, South Africa. Tel: +27 41 399 8700 Fax: +27 41 399 8711

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Pretoria Office
134 Pretorius Street, Pretoria, 0002, South Africa. Private Bag X41, Pretoria, 0001, South Africa.
Tel: +27 12 302 2177 Fax: +27 12 302 2041

Cape Town Office
Plein Park Building, 69-83 Plein Street, Cape Town, 8001, South Africa.
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PO Box 34115, Newton Park, 6055, South Africa. Tel: +27 41 399 8700 Fax: +27 41 399 8711

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Communicating Science in Africa: Shifting Boundaries of Perception

Dr Hester du Plessis

Senior research specialist: Research Use and Impact Assessment (RIA) unit, Human Sciences Research Council (HSRC), Pretoria, South Africa.

Associate researcher: Sustainable energy Technology and Research (SeTAR) Centre, Faculty of Science, University of Johannesburg (UJ), South Africa.

Fellow: Mapungubwe Institute for Strategic Reflection (MISTRA), Midrand, South Africa.

Abstract

There is a growing importance placed on communicating science and promoting Public Understanding of Science (PUS) research in South Africa. This interest comes with new research opportunities but also requires reflection regarding the laying to rest of past socio-political injustices. In a sense, South Africa occupied a similar position after 1994 to that of India shortly after its independence in 1947. Both countries then faced the end of an era of oppression and embarked upon a course of democratisation empowering indigenous societies to make free choices – not least in its relation to science. In this process new problems arose, frequently driven by debates about the destructive application of science (now often informed by cultural worldviews and not manipulated through political and economic dominance). In this regard India made a strategic national choice that served as example: the introduction of the notion of 'scientific temper'. The promotion of such a scientific temper in India positioned the sciences squarely within the Indian society and created a natural bridge between science and society.

The new research opportunities created a growing awareness by science communicators about areas of convergence between the natural and the social sciences. Recognition is given to the fact that artificial barriers have been cemented within academia to segregate disciplines for the purpose of specialization. This segregation often impacts negatively upon the ability of scientists to develop a comprehensive understanding of society and requires adroit dexterousness amongst science communicators to satisfactorily bridge the gap between science and society. With overt attention on the intricacies of the science, issues related to a better understanding of society is repeatedly neglected and often misunderstood. It therefore comes as no surprise that, in the current South African academic landscape, a recent survey established that the social sciences, since South Africa's independence in 1994, "... is in a state of intellectual stagnation and, singular innovations notwithstanding, have remained in this moribund condition for more than fifteen years" (ASSAF, 2011).

In this presentation it will be argued that a balanced perspective is required to ensure the development of a 'science communication' for South Africa that is appropriate to the needs, worldview(s) and histories of its society. A requirement for a healthy academic development of Science Communication in South Africa might lie in the application of a 'Transdisciplinary Research Approach'.

Introduction

We are complex beings that fill the world with complicated systems in order to understand, control and exploit each other and the planet we live on. We continuously interact with our environment in a manner that is characteristically difficult to analyse due to continuous shifts and changes in our environment. According to Paul Cilliers (1998), human beings, representing complex systems, demonstrate a robustness and capability to perform strategically under different circumstances and conditions in order to ensure their survival. In our efforts to self-organise the world, we designed a number of systems, devices and tools to enable us to also function in a synchronised and organised

manner. The separation of knowledge into complicated and organised streams of knowledge, according to what constitutes a discipline, serves as example.

Organised knowledge (originating from René Descartes, 1596–1650) followed efforts to lay a philosophical foundation of western thought during the modern scientific age of the European Enlightenment. To this end, Descartes introduced a form of epistemological foundationalism, based on the assumption of prior (*a priori)* knowledge within a universal (thinking) subject (*cogito)* tradition of thought. In the quest for 'true' knowledge, western philosophers believed that scientific thinking represents the best possibility of achieving this goal. On the strength of the assumption of *a priori* knowledge of the human universal forms of thinking, Descartes argued that philosophy-as-epistemology can best account for the success of scientific thinking and its related ideal of revealing the objective reality (nature) of truth. To reach 'true' knowledge Descartes (1644) introduced a method of systematic doubt, as a pre-requisite for the possibility of achieving absolute certainty (the normative condition with the possibility of truth). The assumption of *a priori* form of knowledge represents the foundationalism of the modern philosophical-epistemological tradition.

Descarte's (1644) philosophy of foundationalism has given respectability to the idea that only reason can provide true knowledge. He defended this idea by stating that empirical knowledge is of lesser importance. Rationalism is taken to be a superior form of knowledge to that of empirical knowledge (the view that all our knowledge is derived from sensory experience). According to Descartes it is because the latter cannot provide the certainty that originates within the structures of *a priori* knowledge. Implicit in Descartes's form of foundationalism is the claim that we can overcome the problem of circular reasoning by demonstrating the possibility of absolute certainty as the source and justification of all knowledge.[2] Descartes, therefore, felt justified to dismiss everything that could not be accounted for in terms of absolute clarity and distinction, which meant that he would dismiss everything that he perceived to fall outside the logical scope of the thinking subject as the privileged seat of rationality. It is from this perspective that we are meant to understand the rhetorical significance of Descartes's (1644) statement; *I think therefore I am.*

Descartes's importance lies in his placement of man as the foundation of rational thought. With man as the centre of knowledge and the seat of rationality, modernity became equated with humanism, and science was given the prestigious position of representing the highest form of human rationality within the modern philosophical tradition.

Immanuel Kant (1781), on the other hand, attempted to demarcate the legitimate limits and limitations of human knowledge and rationality. Kant (1781) emphasised the 'possibility of experience' as the parameter for defining the limits of human knowledge, and he seeks to reveal the underlying universal and necessary *a priori* condition of the 'possibility of knowledge'. According to Kant, although we relate to the world of empirical objects through our senses, we can only know and understand the world on the conditions of certain pre-suppositions, all of which originate in the mind of the thinking subject (man). Without man there can be no knowledge. Empirical knowledge is therefore preceded by an *a priori* conceptual framework, which determines the subject's experience of objects (nature) and knowledge.

For Kant (1784), the possibility of science is accounted for in terms of the philosopher-as-epistemologist's ability to show that science originates from within the cognitive structures of a

[2] Epistemological foundationalism, coupled with the view that empirical knowledge must have a foundation from within, is understood to be "... a belief that possess a degree of epistemic justification or warrant which does not depend, inferentially or otherwise on the justification of other empirical beliefs, but is, instead, somehow immediate or intrinsic" (BonJour in Pojman, 1999:212).

universal subject of knowledge (western man). The Kantian epistemological approach is therefore as foundationalist as that of Descartes in so far as (western) man is privileged as the centre and seat of rationality. Scientific knowledge originates from human rationality (thinking) and as such, it represents the highest form of knowledge and human rationality. Epistemology explains how this is possible by grounding scientific knowledge in the philosophical thinking of man as a rational being. Kant (1784) viewed all forms of dependence on traditional knowledge systems as an expression of intellectual laziness and inferiority. He therefore challenges man as a rational being to have the courage to use his own reason and intelligence in the search for knowledge. As he puts it: "*Sapere Aude!* Have the courage to use your own intelligence!" This became the motto of the enlightenment[3].

Today we face the Cartesian and Kantian legacy that dictated an approach and a way of reasoning that elevated the status of science above that of the social sciences. However, philosophers like J□rgen Habermas and his theory of knowledge-constitutive interests in *The Theory of Communicative Action* (1984), and *The Philosophical Discourse of Modernity* (1987) initiated a change in direction for scientific thinking. According to Habermas (1984), we could begin by distinguishing between empirical-analytic (positivist), hermeneutical (interpretive) and critical approaches in science research. Each of these follows a certain approach that guide the production of knowledge. Empirical-analytical research focus on a technical or instrumental (means-end) interest, hermeneutical (interpretative) research has a practical interest and critical research follows an emancipatory interest. One could now begin to argue that critical social science is under threat from postmodern and poststructuralist challenges – especially under the notion of an emancipatory approach in action research. Habermas's (1987) thesis of 'uncoupling' systems and life-worlds and his thesis of the colonization of the life-world will allow us to look at the differences between steering problems (disciplinary methods) and problems of mutual understanding (interdisciplinary and multi-disciplinary methods).

The notion of a scientific temper

What I tried to establish in the above introduction is to argue that the historically embedded notion that man is central to the growth of knowledge has been a persistent driver in our quest for knowledge. Within this argument comes the embedded assumption that man is a rational being. However, we also witness, as illustrated above, consolidated efforts throughout history to establish 'western man' as exclusively 'rational' and the notion of 'reason' being claimed as the domain of western science.

The introduction of the notion of a 'scientific temper' in India is therefore a dramatic, revolutionary and greatly significant gesture. It requires our attention both in regard to its national application as well as the international significance embedded in the notion of *being able (qualified) to have the ability towards a scientific temper*. Not only does the notion of a scientific temper challenge the artificial barrier between the natural and social sciences. It also challenges the society of researchers to consider a universalist concern for the 'values of life' rather than focussing on narrow and specialized questions of scientific research and application. Investigating issues related to scientific temper provides 'the space to engage in indigenous discourse' and is 'rich with potential for cross-cultural, gender and environmental sensitivity' as stated by the conference organisers. This debate around scientific temper is often burdened by the continuous struggle against the ill-effects of technology and belief systems on society.

[3] Since *a priori* knowledge is considered to precede empirical knowledge (from a logical point of view), Kant (1784) succeeded in establishing a philosophical sense of self-consciousness aimed at justifying scientific knowledge claims. His commitment to scientific thinking is an expression of his acceptance of modernity as the highest form of rationality from a philosophical perspective.

In essence we experience a conflict of interest between human complexity and complicated systems – as demonstrated by Cilliers (1998).

What does the term 'scientific temper' refer to? Shortly before India's independence in 1947, Jawaharlal Nehru took India through the necessary steps of liberation from British colonialism and made vital recommendations for the restructuring of the country. One of the incentives that Nehru introduced was the promotion of a 'scientific temper' amongst the Indian population. Recorded by Pachauri (1983:3), Nehru proposed as follows:

> "People should develop along lines of their own genius and we should avoid imposing anything on them. Tribal rights in land and forest should be protected. We should try to train and build up a team of their own people to do the work of administration and development. We should not over-administer these areas or overwhelm them with a multiplicity of schemes. We should judge results not by statistics or the amount of money spent but by the quality of human life that is involved."

One can argue that a 'scientific temper' is indispensable for acquiring scientific literacy. This is clear when the description of B.M. Udgaonkar (1980) is consulted:

> "... the essence of scientific temper is an active, sensitive, questioning understanding and a creative relationship between man and his environment. It is a rational approach to the discovery of truth through free and creative thinking, experimentation and objective analysis, and a steadfast commitment (with humility not arrogance) to established truth. At the same time it recognizes the tentative and continuous enfolding character of our scientific understanding of phenomena disentangling the different forces and motivations at work" (Udgaonkar, 1980:3).

Of special interest is the post-independence conceptualization of the Indian national identity. Ivan Karp (2000:3) points out that cultural identity in India – strategically linked with science knowledge – was considered to be fairly free from racial issues. In fact, racially motivated assertions were challenged whenever and wherever it cropped up. According to Karp (2000:4) Indian society was, probably due to these collective efforts, seldom accused of a lack of analytical skills.

Africans, on the other hand, had to persistently justify the existence of a 'vaguely collective unconscious' as well as being blamed for not having 'anything remotely akin to philosophy'. This accusation of having a 'collective unconsciousness', disregard individuality and prompted a racially informed idea that African conceptual systems are the product of collective work rather than the elaborations of individuals (Karp, 2000:4). At the same time, the colonial system placed undue value on the thoughts of political leaders, supplementing colonialism with authoritarianism. Therefore, the scientific (common sense) knowledge of the public, as well as individual contributions to science by the colonised, were easily marginalised.

Scientific Temper and Culture

i) Influence of Orientalism

In a way, early scholarly perceptions about India and Africa shared the common fate of being considered as 'the other' in the world of science and research. The most popular and influential perceptions came from the research field of 'Orientalism'. Orientalism served, firstly, as an academic term. According to Edward Said (1978:2) "... anyone that teaches, writes about or researches as sociologist, historian or philologist – either in its specific or its general aspects [of the East] – is an

Orientalist". Secondly, Orientalism has a more general meaning and is "... a style of thought based upon an ontological and epistemological distinction between 'the Orient' and 'the Occident'" (Said, 1978:2). Thirdly, Oriental Studies are historically and materially defined, making it possible that the Orient "... can be discussed and analyzed as the corporate institution dealing with the Orient" (Said, 1978:3). The Orient was experienced through the lenses of "... the journey, the history, the fable, the stereotype, and the polemical confrontation' of western travellers and artists" (Said, 1978:58–59). When confronted with a foreign world, the trend is to see the foreign as just a version of a previously known entity and thereby becoming not so much new information but 'a method of controlling what seems to be a thread to some established view of things' (Said, 1978:58–59).

The Orientalists provided a sublime platform for an intellectual debate that culminated in Edward Said's (1995) creation of the concept of 'the other'. It facilitated a continuous exploration of the conceptually linked objective and subjective worlds and complex relationships between divergent east and west cultures and identities. Syed Hussein Alatas, author of *The Myth of the Lazy Native* (1977), tried to analyse the lasting effects of Orientalism by contesting its enduring stereotypes. Homi Bhaba in his *The Location of Culture* (1994) saw Orientalism as an apparatus of power, created to provide space to control the knowledge production of the subjects by the colonizer and to construe 'the colonized as a population of degenerate types on the basis of racial origin, in order to justify conquest and to establish systems of administration and instruction' (Bhabha, 1994:70). Anouar Abdel-Malek (1981) distinguished between *'traditional Orientalism'* and *'neo-Orientalism'* and considered both groups to be guilty of treating the Orient as an 'object of study inscribed by Otherness'. A. L. Tibawi (1964), in his classic study on the English colonial approach to Islam and Arab nationalism criticized Orientalist scholarship of lacked clear thinking, objective standards and basic courtesy, tolerance and moderation towards Muslim points of view.

Ziauddin Sardar (1999:vii) considered the term Orientalism to represent an incomplete partisan subject as well as an artificial construction by the west and argued that the Orient provided Europe with suitable contrasting images, ideas, personalities and experiences. In similar vein Edward Said (1995) studied routine comparisons made throughout the ages of the differences between East and West whereby in the hands of the philosophers, and all who shared their intellectual temper, the Orient was a treasury of ideas for rethinking and remodelling European attitudes and understanding. To summarise the influence of Orientalism it is apt to comment that the Orient is perceived to be a constant source of ideas to feed western political needs and aims which are conceptually influenced by the current politics of the time.

ii) Cultural differences

Conceptual difficulties arise when trying to understand different cultural objectives that originates and exists within diverse cultural contexts (Gouthier 2005). These conceptual difficulties are aggravated by the perceived division that exist in the western world between the roles of the scientist on the one hand and his/her obligation towards the public at large. It is undoubtedly true that different ideologies will influence science perceptions and create different social realities in a variety of cultures. In the debate regarding cultural differences, for example, the role of constructivist criticism surfaced among researchers who specifically consider the contribution to science by the *'lay-knowledge'* of non-experts as valuable.

In this regard, Wynne (1995) highlighted the importance of social context and the legitimacy of local knowledge as an important basis for the application of science by members of the public. Deemed

important is the fact that there are communities and societies that constantly exchange scientific information without being explicitly aware of it – and without directly interacting with the formal scientific world. Wynne (1995) argued that communities consist of individuals who not only *receive* scientific information but also *provide* information to scientists.

However, Steve Fuller (2007) indicates that science, in its function as 'common sense', is rendered 'self-conscious' by modernity. This current self-concern happened despite the fact that human beings flourished, over millennia, in their 'right to life' in an ever-expanding variety of environments. As a result, science, according to Fuller (2007), in a sense overestimates the human 'being in the world' in its efforts to control the natural environment. However, modern science developed a set of principles to organise the 'imperfect reasoning of society' and engage in efforts to enable scientists to bend the world to their collective will. This makes science a highly disciplined 'social movement' – a movement that we can refer to as a vocation (Fuller, 2007:158).

Science Communication in a Culturally Complex World

Gauhar Raza (2002) stated that the intrusions of modern technologies in people's lives and education have a bearing on the structure of people's thinking. This observation is an important contribution to the current Public Understanding of Science (PUS) *'science-in-and-of-society'* paradigm (mid-1990s to present). The 'science-in-and-of-society' paradigm gives recognition to the fact that "... science and technology operate in society and therefore stand relative to other sectors of society" (Bauer, 2008:122). The advantages of PUS research is recognised in its contribution to policy as well as its being a facilitator for bringing together multi-disciplinary researchers in the areas of the sciences and the social sciences.

Though Europe still dominates the field of PUS, it is becoming clear that countries such as India and China have been working 'quietly and on the side' in the field of PUS for up to 30 years. We are now experiencing an awareness of the wealth of information embedded in the so-called developing world's research efforts in the field of PUS. Raza (2002:57–58) stated that developmental models for the third world countries often originate in the west with a '... lack of understanding of culture, which is a decisive force and which inhibits or accelerates the pace of accepting science and technology in a society, introducing distortions in the social fabric". What is required, according to Raza (2002), is a deeper insight into the cultural complexities of thought prevalent in a society to ensure workable solutions for socio-technical problems. Of utmost importance is the deliberate inclusion and acknowledgement of Indigenous Knowledge Systems (IKS) in PUS research. This, in turn, requires the acknowledgement of prevalent cultural practices, social and technical concerns existing within specific geographical locations and the socio-political impact of market forces (global as well as local) on indigenous populations.

However, science communication research is still guided by the 'scientific literacy' paradigm (1960s to mid-1980s) which was built on two ideas: science education [that] is essentially part of the secular drive for basic literacy in reading, writing and numeracy; and science literacy [that] is a necessary part of civic competence (Bauer, 2008: 115). Jon Miller (1998) who designed surveys to establish society's science literacy in the early 1980s, considered four elements to essentially guide the process:

i. knowledge of basic textbook facts of science;
ii. an understanding of scientific methods such as probability reasoning and experimental design;
iii. an appreciation of the positive outcomes of science and technology for science;

iv. the rejection of superstitious beliefs such as astrology or numerology.

Though establishing a population's level of science literacy is a handy measure for governments to guide policy as well as indicate educational progress in the fields of science, too many serviceable factors are left out. When we consider the original intent to establish a population's science literacy, as proposed by Shen (1975), it is becoming clear that we currently face a highly selective and exclusive perception of the science literacy domain. The three types originally proposed consisted of:

- 'practical scientific literacy' which indicates the possession of a kind of scientific knowledge that is used to solve practical problems;
- 'civic scientific literacy' that enables citizens to become aware of science and the scientific process in order to participate in the politically democratic processes;
- 'cultural scientific literacy' which is the knowledge and appreciation of science as a major human achievement and a cultural heritage (Shen 1975:50).

Science and Society in South Africa: The Struggle for Reason

The roots of the *Science and Society* paradigm, though fairly firmly entrenched in Europe, have reached global proportions and countries such as India and China are exerting growing influence in its conceptual development. However, despite embracing the science and society paradigm through a number of events such as the Science and Society Conference in 1998 organised by the National research Foundation (NRF) in Pretoria, there is little evidence in South Africa of a systematic and thorough theoretical understanding of PUS. Some reason can be found on a socio-political level where South Africa has only fairly recently reached the end of eras of colonial occupation. Attention to political reformation and transformation, understandably, is currently of primary concern. The current 'post-colonial social movement', however, inspires a fair amount of research that reflects upon and focuses on all kinds of aspects that influenced the lives of the dispersed people and disempowered communities under the apartheid regime. To do so implies that researchers are progressively moving away from discipline-bound research. The application of a Transdisciplinary research approach is mooted as possible solution to overcome disciplinary restrictions.

i) Which society?

The complexity of the South African society is well known. In an effort to capture the diversity and variety of ethnic groups, South Africa is often referred to as the rainbow nation. Within this complexity lie complicated cultural practises, characterised by a constantly fluctuating cultural tolerance between racial groups.

Since the end of apartheid (1994) the socio-economic situation has worsened for the majority of South Africans (Gibson, 2011:73). Poverty has deepened from two million people living on a dollar a day in 1994 to doubling that amount to four million of 2006 (Klein, 2007:215). Stats SA 2010 indicated that over a third of children among the poorest 40% of the population suffer chronic malnutrition, 20% of urban households have no electricity, 25% have no running water and life expectancy dropped from 48.4 years in 2003 to 43.3 in 2005. Factors that are debilitating South African growth perspectives are related to the high count of HIV/AIDS cases, a deepening racial mistrust (Gauteng Review 2011) and a progressively dysfunctional health care and education system. Against this background of slow decay of the social infrastructures one sees that South Africa "... remains a multi-cultural, not a non-racial, society where the correlation between race and poverty remains extremely strong" (Gibson, 2011: 73).

In South Africa the legacy of racial separation and conflict is complex and a better understanding of the underlying tensions that feed into the growing racial divide can, in part, be found in the historical alliance between science and philosophy. The seeds were planted in the remote history of mankind whereby man was identified as 'being rational' as was previously discussed. A damning opinion against this Cartesian definition of 'man as rational being' is expressed by Mogobe Ramose (2002) in his reference to the deliberate exclusion of the African, Ameridian and Australasian from 'being rational' and therefore being 'not human'. That this is still a prevalent problem is well illustrated by the outcry by America against placing the issue on restitution against the injustice of colonialisation and slavery at the United Nations conference on racism that was held in 2001 in Durban, South Africa[4]. The item was removed from the agenda. Ramose (2002:3) afterwards questioned this move as a defeat for Africa, which shifted the *struggle for reason* not only from outside but also from within Africa. There is, according to Ramose (2002:3) no hierarchy in measuring the value of one human life over another and the question persists "... why is it that the African's right to life continues to be denied, derecognised and remains practically unprotected by the beneficiaries of the violence, irrationality and the inhumanity of colonialisation?"

To Ramose (2002) the persistent *struggle for reason* and the repeated classification of 'who is rational and who is not' is the foundation of racism and prevents the establishment of a democracy and a culture of human rights in Africa. The large-scale embracement of western philosophy in its denial of African rationality causes Ramose (2002:5) to state that "... the mimetic and the decontextualized character of the teaching of western philosophy in Africa calls for a radical overhaul of the whole epistemological paradigm underlying the current education system".

The topics of reason and rationality serve as driver for a large amount of philosophy coming from Africa illustrating engagement with both intent and content on the subject. For instance, joining the argument of 'man as rational being', Ivan Karp and D A Masolo (2000:4) shifted this debate within an Indian context by declaring that: "... ideas about race have shaped the ways that African philosophers have developed their critiques. The racially informed idea that African conceptual systems are the product of collective work rather than the elaborations of individuals is unthinkable with regard to Indian religion and philosophy, which early on became the subject of civilizational discourse of orientalist disciplines".

By the end of the nineteenth century, European and Indian academics alike were asking how and to what degree Indian cultural forms exhibited the features of civilization (Chatterjee 1995). As a result, a large body of material about Indian philosophy and religion was written to challenge racially motivated assertions; such a body of material did not exist for African philosophers at the end of the colonial period. "Indian philosophy was never asked to refute the idea that there were no analytical skills available in Indian culture, while African philosophy has always had to justify the very idea that African culture had anything remote akin to philosophy, except at the level of a vaguely formulated collective unconscious" (Karp & Masolo, 2004:4).

ii) Transdisciplinarity to the rescue?

One can safely assume that issues related to people's worldview, level of education, application of Indigenous Knowledge Systems and socio-political circumstances all impact on successful

[4] The 2001 UN Conference declared in the Durban declaration of the World Conference against Racism, Racial Discrimination, Xenophobia and related intolerance: *"...colonialism has led to racism, racial discrimination, xenophobia and related intolerance, and .... Africans and peoples of African descent and people of Asian descent and indigenous peoples were victims of colonialism and continue to be victims of its consequences"* (Eze, 2008:55).

communication of science. Considering all these diverse issues within a research project is difficult. Therefore, currently in South Africa, there is a growing interest in the application of Transdisciplinarity as a research approach. Examples range from adopting Transdisciplinarity by academic institutions such as the University of Fort Hare, the think tank Mapungubwe Institute for Strategic Reflection, the Sustainable energy Technology and Research (SeTAR) Centre at the University of Johannesburg and talks are on the table to explore this approach as a possibility at the Human Sciences Research Centre (HSRC).

What has Transdisciplinarity to offer science communicators? Michael Gibbons (1984, 1994) explored a new way to conceptualise research methodology by arguing that science and research must be viewed as a process of social interaction that cuts across the borders of the strictly defined (limited) academic disciplines. In his attempt to demonstrate that there is more to knowledge than the research generated in academic institutions, Gibbons (1984:22) identified two models or *modes:*

- The conventional, discipline-bound way of research "Mode 1", where knowledge "... is validated by the sanction of a clearly defined community of specialists"
- When one shifted outside the parameters established by accepted research paradigms and academically constructed disciplines, one started to work in "Mode 2" or in a transdisciplinary mode.

Gibbons (1984), in his support for an alternative way of looking at the production of knowledge (Mode 2), inadvertently proposed an alternative route for research methods that suits a Transdisciplinary research approach. Utilising the second mode, Gibbons hoped to supplement shortcomings and inadequacies within the established discipline-bound areas of specialisation, where the scientist/researcher is often viewed as an independent (and isolated) agent of knowledge, with no need to consult outside the field of his specialised interest. Gibbons (1994:4) further proposed a methodology that would integrate different skills across various social and cultural traditions into a 'framework of action'. The purpose of the establishment of a framework of action is to investigate a possibility of consensus across and between disciplines. In this transdisciplinary methodological process Gibbons (1994) identified four main advantages:

- Transdisciplinarity "... develops a distinct but evolving framework to guide problem solving efforts" (Gibbons, 1994:5). The emphasis is on the development of the process/methodology as part of the research process and, contrary to the methods of Mode 1, is not first designed and then applied to solve the problem. This provides the researcher with the opportunity to be creative and to apply a process of bricolage by making use of methods best suited to get the proper processes covered.
- Transdisciplinarity engages with both empirical and theoretical aspects of knowledge that originates from within 'a particular context of application', and although this combination adds to the growth of knowledge, the accumulative effort does not necessarily fall within a discipline and can therefore shift into any direction even after a particular problem has been solved (Gibbons, 1994:5).
- Transdisciplinarity transcends the limitations of communication, and is capable of breaking down the barriers to knowledge communication by establishing a relationship of dialogue between the researcher and the community. This may lead to an endless re-configuration and re-application of research findings. It will also break down the stereotype of associating and restricting the production of knowledge to the domain of the university.

- Transdisciplinarity is a dynamic process. Establishing a closer interaction of knowledge production with a succession of 'problem contexts', the possibility of communication of shared interest of research adds new impetus and meaning to the research process as a whole. The key factor in the research method is based on facilitating communication (Gibbons, 1994:5).

Gibbons (1994) further identified the heterogeneity and organizational diversity of the process through challenges such as:

i. Recognising that outside of the university there are authentic and potential sites of knowledge. This indicates an acceptance that universities and colleges could fruitfully work with non-university institutes, research centres, government agencies, industrial laboratories, think-tanks, consultancies and individuals.
ii. Establishing communication links between the various sites of knowledge. Functioning networks of electronic, digital, organizational, social and even informal channels of communication feeds into the following point.
iii. Re-combining and re-figuring various fields and sub-fields of knowledge production to form the basis for new forms of knowledge. From this perspective knowledge production must move increasingly away from traditional disciplinary activity into new societal contexts (Gibbons, 1994:6).

Taking the concept of a Transdisciplinary approach further, Basarab Nicolescu (2002) interrogated the helplessness of the application of a proliferation of knowledge and knowledge systems. His hypothesis is based on, as he sees it, the pending 'fall of civilization' whereby social revolution(s), being a symptom of the failure of civilization, expose humankind's failure to live in harmony (with both the planet and each other). The social movements, even in their frustration against current society, are unable to envisage any kind of ideal/utopia to strive for. The message is clear enough: we failed in this civilization to promote harmony and social justice and we have turned upon each other in a form of 'interior revolution'.

In a humanely and optimistic manner, Nicolescu (2002) offers a plausible solution to this 'civilizational stalemate'. According to his reasoning, bridging the gap between the disciplines serves as a possible solution in the effort to understand the present world. To move beyond the restricted sphere of disciplinary bound applicability he identifies the presence of several levels of Reality and tenders the application of transdisciplinarity to address the concern of "... the dynamics engendered by the action of several levels of reality at once".

Nicolescu (1996) introduced a methodology of three axioms: the ontological axiom, the logical axiom and the complexity axiom. In the conceptualization of a transdisciplinary approach to research he saw similarities between disciplines spanning from the natural sciences to the social sciences (neurophysiological discoveries, quantum mechanics, quantum theory and philosophy):

- What he considers as the 'ontological axiom' refers to what we encounter in nature and in our knowledge of nature: there exist different levels of reality and, correspondingly, different levels of perception.
- The 'logical axiom' refers to the passage from one level of reality to another, ensured by the logic of the included middle.
- The 'complexity axiom' forms the structure of the totality of levels of reality or perception and as complex structure: every level is what it is because all the levels exist at the same time.

Axioms are not theorems and cannot be demonstrated; they have their roots in experimental data and theoretical approaches and their validity is judged by the results of their application. Looking at "... modern science that was born through a violent break with the ancient vision of the world", he considers the crucial point of change the status of the Subject. This change is caused by the total separation between the knowing subject and reality. Instead of looking at transdisciplinarity as an approach that is promoting continuity, he advises the consideration of discontinuity since, what he calls 'the middle ground', consists of a vacuum. This vacuum, according to him, is filled with possibilities of the 'unknown'[5].

However, there is more to transdisciplinarity than a quest to apply a practical method by 'following a transdisciplinarity approach'. There is the problem of communicating science/knowledge between disciplines, amongst scientists and with the general public. Max-Neef (2005) summarises the problems related to effective communication with his statement that: "... the growing rupture in communication is, to a great extent, the product of the exacerbation of rational thought, which manifests itself through the predominance of reductionism and of a binary and linear logic that, among other shortcomings, separates the observer from the observed". What we see in the final place is that the western legacy of rationality has become the dominant measure for all thinking and leaves little space as a field of mental acts in perception, understanding and explanation of alternative or different worldviews or methodologies.

The importance of introducing a scientific temper, as demonstrated by India, should therefore be considered as an open invitation to challenge existing paradigms, notions and dominances. It invites society to join the world of research as a valuable contributor to the growth of knowledge.

Conclusion

In conclusion one should again laud the forward thinking of great statesmen such as Nehru who had the insight and political insight to place, as primary concern, a notion such as 'scientific temper' as driver for democracy. It is only by comparing the effects of this act with countries where the ability *to be scientific* has been deliberately undermined that the true value of this introduction of *all people's capability in science* can be clearly appreciated.

In this presentation I strived to build an argument that demonstrates possibilities – as well as the odds against – a global introduction of a scientific temper. Over-specialisation, academic diversions as demonstrated by Orientalism and lasting perceptions of cultural stereotypes place obstacles in the way we look and apply science communication. I introduced the idea of applying Transdisciplinarity as a solution for this disciplinary stalemate and as a way forward to promote science communication in its application and theoretical development.

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[5] Acknowledgement of the Charter of Transdisciplinarity that was drafted during the First World Congress of Transdisciplinarity in 1994, as a reaction against "8,530 definable fields of knowledge...as the result of both increasing specialisation and overlapping domains" is crucial. Our challenge will be to deliver outcomes in the spirit of the Transdisciplinarity Article 13 of the 1994 Charter of Transdisciplinarity which states. "The transdisciplinary ethic rejects any attitude which refuses dialogue and discussion, no matter whether the origin of this attitude is ideological, scientistic, religious, economic, political or philosophical. Shared knowledge should lead to a shared understanding based on an absolute respect for the collective and individual diversities united by our common life on one and the same Earth" (adopted at the First world Congress of Transdisciplinarity, Convento da Arrábida, Portugal, November 1994).

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Dr HESTER DU PLESSIS (DLitt et Phil Philosophy) is a Senior Research Specialist in the Research Use and Impact Assessment (RIA) unit at the Human Sciences Research Council of South Africa. She has extensive academic experience in the field of Art and Design. Her current area of research is in Public Understanding of Science. She works in collaboration with the Science Communication through Multi-Media research team at the National Institute of Science Communication and Information Resources of the Council for Scientific and Industrial Research in New Delhi, India. She is an Associate Researcher at the Sustainable Energy Technology and Research (SeTAR) Centre, Faculty of Science, University of Johannesburg. At the SeTAR Centre, she collaborates on a research programme on the Public Understanding of Science as well as a research programme on affordable alternative energy as a key element for sustainable development. She is a Fellow at the Mapungubwe Institute for Strategic Reflection and a team member of 'The concept and application of transdisciplinarity in intellectual discourse and research' project.

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Website: www.niscair.res.in

Introduction

This volume consists of papers, extended abstracts and abstracts to be presented during the three-day International Conference on 'Science Communication for Scientific Temper'. When the Organising Committee of the conference gave a call for submission of abstracts, bringing out a volume of this nature seemed to be a distant dream. The overwhelming response to the call gave us confidence that this would not remain a dream, after all, and that we would be able to bring out a volume containing abstracts. After the abstracts were reviewed, accepted or rejected as the case was, in its wisdom, the Organising Committee decided to try for a higher goal: Request all the contributors to submit full papers and try to print as many as possible in the pre-proceeedings volume.

Some of the committee members strongly felt that, in most cases, after the conference, the fizz is lost and more often than not Proceedings never see the light of the day. Some members argued that we might not receive sufficient numbers of full papers in time. There was also an apprehension that a hurried job might compromise the quality of the document. Finally, it was decided that due to paucity of time, once the papers had been reviewed, we would undertake only language editing, there being no time left to critically analyse the contents of each paper and send these back to the contributors along with reviewers' comments. However, before sending the preproceedigs to press all the edited paper were sent to the authors.

We were determined to consolidate the gains of the conference to the extent it was possible. It was finally decided that after the conference was over we would try to bring out a volume of selected papers on 'scientific temper'. These decisions, consequently, meant a lot of work for the NISCAIR team of organisers. We had to stretch the capabilities of editors, designers and the printing section to the brink.

A majority of contributors responded positively to our suggestion of bringing out the pre-proceedings. However, as time passed we had to request, plead, cajole and persuade some of the colleagues to send their articles in time. By the time the volume went for printing, of the **94** abstracts selected by the reviewers **54** sent their full-length papers or extended abstracts. Quite a number of these were just first drafts, the time was short for us, and so was it for the contributors.

It was a conscious decision to invite a proper mix of contributors who could be put into three categories. First, there were those who have for decades engaged with issues of science communication, public understanding of science and scientific temper. Second, those who have been actively involved in communication of science through various media and had been invited to deliberate. These colleagues could further be divided into two segments: those who directly interact with the public through interpersonal media and are members of science popularisation organisations and those who communicate science through the mass media. The third category is composed of the young new comers to the area.

The volume, in its opening sections, contains the Scientific Temper Statement, 1981, **followed by the** Scientific Temper Statement Revisited—2011: The Palampur Declaration. **We have also included the Resolutions adopted at the International Meet on "Mapping the Scientific Consciousness: National and Global Efforts" held in New Delhi, 7-8 March 2008.**

All the articles, extended-abstracts and abstracts to be presented during the five plenary sessions have been placed together in the beginning of the volume. The articles, extended-abstracts and abstracts to be presented in parallel sessions are sequentially arranged according to day-wise proceedings.

The language editors have tried to do their best in the available time. However, we are conscious that given more time the document could have been improved by many notches. We do take the responsibility of typographical errors and language shortcoming but are in no way responsible for the academic content of individual articles. We also do not take any responsibility for the inconsistencies in the arguments and validity of the data.

Language Editors

Gauhar Raza
Hasan Jawaid Khan
PVS Kumar
Surjit Singh
RS Jayasomu
G Mahesh

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