Southeast Asian and Japanese Cultural Influences on the Understanding of Scientific Concepts

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Purpose of the Project

- To analyze cultural incommensurability between scientific terms in the English language and indigenous Southeast Asian languages.
- To recommend ways of overcoming cultural incommensurability between scientific terms in the English language and indigenous Southeast Asian languages to enhance the teaching of science in Southeast Asia.
- To disseminate information on overcoming cultural incommensurability between scientific terms in the English language and indigenous Southeast Asian languages among science teachers and science teacher educators in Southeast Asia..

Background of the Project

This project is part of an emerging series of research in critical constructivism that is aimed towards the goal of cultural reform in science education by giving due consideration to cultural and linguistic relativism in science and science education. Some of the recent Japanese and international studies that work towards this goal include

Ogawa (1995, 1998), Kawasaki (1996, 1999, 2002), Cobern (1996, 1998), Loo (2001), and Rollnick & Rutherford (1996).

The interaction between indigenous cultural systems and modern science has been a topic of much interest in recent studies (Cobern, 1996; Kawasaki, 1996; Ogawa, 1998; Loo, 1996, 1998, 2001). Many constructivist studies have shown that far from being an objective way of knowing, there is much subjectivity and cultural relativism that may undermine the learning of science.

Of particular interest in recent studies is the role of language in the learning of science. The dominant global language used for the teaching of science is the English language. As a result of that, when science is taught in the mother tongue languages of other cultures, e.g. Japanese and Bahasa Malaysia (or the Malay language), scientific terms in the English language are directly translated to what is deemed to be the closest equivalent in another language. In the process of translation, cultural and linguistic incommensurabilities are often not taken into account. For example, in the early history of Western science, the influence of Christianity on the scientific worldview was so powerful that the word 'nature' can only be understood in the context of the 'Creation' of the 'Creator' (Cobern, 1998). However, since the Renaissance, there has been a progressive secularization of science, resulting in the present day essentialist understanding and study of 'nature' in Western science without consideration of supernatural causes and from which the individual observer is detached in order to study it objectively.

In contrast, Ogawa (1995) highlights the fact that there is culture-laden understanding of scientific terms. Cultural dissonance may be created when, for example, the word 'nature' is translated to 'shizen' in the Japanese language. According to Ogawa, 'shizen' is Japan's "collective representation" of what the world is really like and how one should relate to that world. Thus, unlike the observation of 'nature' by Western people, Japanese people do not detach themselves from 'shizen' and Japanese culture in the process of observing it. Furthermore 'shizen' is inseparable from the supernatural process of being made so by itself (jinen) as both 'shizen' and 'jinen' share the same kanji characters (Kawasaki, 1996).

Similarly, the word 'nature' does not correspond to equivalent terms in indigenous Southeast Asian languages. For example, the Bahasa Malaysia term, 'alam', is derived from the Arabic word 'alm' which is grounded in the Islamic cultural worldview. Islam has much in common with Judaism and Christianity - the three religions are often referred to as the Abrahamic faiths because all three began with the Divine calling of the patriarch, Abraham or Ibrahim where Muslims are concerned. The understanding of 'alam' is quite close to the early Christian understanding of 'nature' as being inseparable from God, the Creator as it is the Creation of God. Thus, like the Japanese, Malaysians may have an anti-essentialist culture-laden cognition of 'nature'. Under the Malaysian secondary school curriculum, students are inculcated with the moral value of man as the 'khalifah' (steward) of God charged with the responsibility of managing 'alam' in a responsible manner. In a certain sense, this relates to the objectives of the Japanese science curriculum where "pupils are to learn by direct interaction with Shizen, feel Shizen, feel empathy with Shizen, and to love Shizen" (Ogawa, 1998, 156).

Another term where cultural and linguistic incommensurability arise is when 'observe' is translated into 'kansatsu' in the Japanese language and 'memerhatikan' in Bahasa Malaysia respectively. The English term 'observe' refers to the objective collection of sense data by an individual observer who is detached from what he/she is observing. On the other hand, 'kansatsu' is not detached from 'shizen' that is observed because 'kansatsu' involves empathy and being united with what is being observed and

leads the observer to an intuition for feeling empathy with 'shizen' - the object under observation (Kawasaki, 1999).

Similarly, there is cultural and linguistic incommensurability when 'observe' is translated to equivalent terms in indigenous Southeast Asian languages. For example, in Bahasa Malaysia, the word 'memerhatikan' is formed by adding the prefix "memer" and the suffix 'kan' to the root word 'hati'. The word 'hati' refers to the emotional heart as contrasted with 'jantung' the physical heart. Thus, 'hati' is the seat of intuition and emotions in an individual in Malay culture. It can thus be said that when Malaysians 'observe', they are not only supposed to use their eyes but also their hearts. Once again, the intuitive nature of 'memerhatikan' is grounded in the Islamic worldview where the rational intellect (the head) and the intuitive intellect (the heart) are united as one (Loo, 1996).

The significance of this study is that it will help contribute towards the equitable treatment of non-Western cultural perspectives in science and science education. The present essentialist linguistic mode of science education based on the direct translation of scientific terms in the English language into other languages, in particular Japanese and indigenous Southeast Asian languages, is flawed because it does not take into consideration the problems of cultural and linguistic relativism when pupils learn science in a culture-laden cognitive situation.

Another significant contribution of the research project is the validation of the geometry-structure model of Kawasaki (2003) to study language-culture incommensurability in science education at the end of the fieldwork in Malaysia and Japan. It is hoped that the model will contribute towards helping pupils to express their subjectivity-conscious understanding of science and helping them bridge the cultural gap in understanding between scientific terms written in the English language and subsequently translated into indigenous Southeast Asian languages.

Description of the Project

A total of 50 science educators from Southeast Asia and Australia and the Japanese consultant for the project, Professor Ken Kawasaki were invited by the project director to participate in a Japan Foundation Intellectual Exchange Project (IEP) Workshop. The IEP workshop was held at RECSAM-SEAMEO from 3 to 5 October 2005.

During the workshop 3 keynote addresses were presented by the Japanese consultant and the project director. After the keynote sessions, the participants broke up into discussion groups to prepare the country report on language-culture incommensurability in science. A total of 6 country reports (Malaysia, Philippines, Myanmar, Vietnam, Thailand and Australia) were then presented. This report includes all the keynote presentations and country reports as well as additional papers prepared by other workshop participants.

Acknowledgement

The editors of this proceedings acknowledge the generosity of the Japan Foundation in making this IEP project a resounding success.

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Appendix A (PowerPoint Presentations)

KEYNOTE PAPERS

The Two Cultures of Science: On Language-Culture Incommensurability Concerning 'Nature' and 'Observation'[1]

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Abstract: Intercultural dialogue in higher education around the globe is essential towards improving the theory, policy and practice of science and science education. The culture, cosmology, and philosophy of 'global' science as practiced today in all societies around the world is seemingly anchored in the cozy inter-Atlantic Occidental relationship that dominates the world that we know today, which whilst giving cursory acknowledgement to the contributions of preceding civilizations, somehow fails to give due recognition to the contributions of non-Occidental and non-Platonic thinking that preceded Greco-Roman thought. This essay analyzes language-culture incommensurability pertaining to the concepts of 'nature' and 'observation' from the so-called 'Western' and 'Eastern' perspectives; in so doing, proposes a thesis that there exists two broad cultures of science.

Keywords:

Higher Education; International Comparison; Intercultural Learning and Dialogue; Science and Culture

Background

This essay is the outcome of the privilege accorded by the Japan Foundation to the author as project director to lead an intellectual exchange project entitled *Southeast Asian and Japanese cultural influences on the understanding of scientific concepts*[2] for fiscal year 2005. The title of this essay is inspired by Snow's seminal essay: *The Two Cultures and the Scientific Revolution* (Snow, 1959). Snow argued that the world of human thought and experience is split in the incommensurable cultural divide between science and the humanities/literature. Nevertheless, the author disagrees with Snow's suggestion that there exists only one culture of science.

This above-mentioned project is part of an emerging series of research in critical constructivism and cultural relativism in science that is aimed towards the goal of cultural reform in science education by giving due consideration to cultural and linguistic relativism in science and science education. Some of the recent international studies that work towards this goal include Ogawa (1995, 1998), Kawasaki (1996, 1999, 2003), Cobern (1996, 1998), Loo (2001), and Rollnick and Rutherford (1996).

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[1] This paper has been submitted for publication in the *Higher Education Policy* and is currently under review.

[2] The author, as project director, acknowledges the generosity of the Japan Foundation in granting funds for the Intellectual Exchange Project for fiscal year 2005-2006 entitled *Southeast Asian and Japanese cultural influences on the understanding of scientific concepts* (Ref. No.: 17 RIE-RC –A05086)

The interaction between indigenous cultural systems and modern science has been a topic of much interest in recent studies (Cobern, 1996; Kawasaki, 1996; Ogawa, 1998; Loo, 1996, 1998, 2001). Many constructivist studies have shown that far from being an objective way of knowing, there is much subjectivity and cultural relativism that may both undermine and enrich the learning of science.

Introduction

The year 2005 marks the centenary of the birth and 25th anniversary of the death of Charles Percy Snow (October 15, 1905 – July 1, 1980). C.P. Snow was one of a unique and rare breed of men whose life and works spanned the entire spectrum between the science and the humanities and the sharp divide between the social classes of Britain's highly conscious, somewhat contradictory class-based capitalist society with a significant feudal vestige. The peerless C.P. Snow is the epitome of a commoner who rose from a poor home background into a knighthood in 1957 and a life peer as Baron Snow of his home city of Leicester in 1964. He was a man who could equally rub shoulders with the masses and people of 'high culture', a man of the arts and science; yet able to express what he observed around him in his uniquely uninhibited, sincere and upfront language.

Physicist, novelist, and onetime Minister in the Government of Harold Wilson, Snow is best-known for his highly influential polemic entitled *The Two Cultures and the Scientific Revolution* penned slightly over half a century ago that has provoked debate well into the third millennium. The debate has engaged not only the so-called First and New Worlds on both sides of the Atlantic but also the often forgotten 'Third World'. Snow first outlined a problem which had been on his mind for some time in the New Statesman of 6 October 1956. *The Two Cultures* highlights Snow's seminal thesis of the apparently incommensurable cultural chasm between science and the humanities in general, and the scientific and literary communities in particular. If the first thoughts of Snow had gone unnoticed, *The Two Cultures* undoubtedly caught the undying attention of the worlds of scientists and 'intellectuals' on both sides of the purported cultural divide in academia, when it was delivered in the prestigious 1959 Rede lecture in Snow's inimitable brash, unpretentious and uncompromising style at the University of Cambridge. Snow's Rede Lecture was published as a book in the same year (Snow, 1959) and as an expanded version with a 'second look' was published in 1964 (Snow, 1964).

The basic premise of Snow's thesis is that the breakdown of communication between the "two cultures" of 'modern' society – science and the humanities – is a major hindrance towards solving the world's problems. Snow's *Two Cultures* has been both widely supported and attacked. Perhaps the most vitriolic, dissenting opinion from the literary establishment was expressed by F.R. Leavis, in a *Richmond* lecture at the University of Cambridge in 1962, subsequently published in the *Spectator* and also in book form (Leavis, 1962), who could have taken exception at Snow's charge that:

> "Literature changes more slowly than science. It hasn't the same automatic corrective, and so its misguided periods are longer." (Snow 1964, p.8)

Leavis dismissed Snow as a "public relations man" for the scientific establishment although Snow had immediately added the disclaimer in the next sentence of *The Two Cultures*:

> "But it is ill-considered of scientists to judge writers on the evidence of the period 1914-50." (*ibid*, p.8)

Perhaps one of the most notable anecdotal observations of Snow (who could comfortably break bread both with scientists and the literati) on the mutual 'neolithic' 'incomprehensibility' on both sides of the cultural divide – as judged by the ethereal standards of 'traditional culture' of the 'highly educated' (who at least in Snow's days, were apparently too pessimistically focused on 'the human condition'); and the scientific illiteracy of the literati as judged by the finest and purest concepts of science in the Platonic essentialist sense of scientists (who at the time of Snow, were apparently too optimistically convinced about the power of science to solve all the world's problems), was:

> "A good many times I have been present at gatherings of people who, by the standards of the traditional culture, are thought highly educated and who have with considerable gusto been expressing their incredulity at the illiteracy of scientists. Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: 'Have *you read a work of Shakespeare's?*'
>
> I now believe that if I had asked an even simpler question – such as, What do you mean by mass, or acceleration, which is the scientific equivalent of saying, 'Can you read?' – not more than one in ten of the highly educated would have felt that I was speaking the same language. So the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their neolithic ancestors would have had."
>
> (Snow, 1964: 14-15)

The author of this essay aims to, firstly, extend the scope of Snow's debate to the furthest limit – what is meant by 'culture' – that, in the final analysis, due acknowledgement be given to non-Occidental views of philosophy and cosmology of science in the debate because the peoples of the Near and Far East' were already living in civilized, culturally and scientific literate societies at the time that the largely Caucasian population of the 'West' languished in a condition considered as 'barbaric' by the standards of their own Greco-Roman legacy but the peoples of the 'East' supposedly 'surrendered' leadership in science to the West in the course of history; secondly, to challenge Snow's thesis that there exists only one culture of science anchored in an apparently exclusive, cozy inter-Atlantic shared view that science is largely an Occidental legacy to the rest of humanity; and perhaps, thirdly, to have the temerity to suggest the ultimate 'two-science' heresy (Matthews, 1994: 196), one anchored in the dualistic philosophical *weltanschauung* of the West, the other in the monistic philosophy of the East. With respect to the last-mentioned aim, Snow rightly pointed out that the number '2' is a very dangerous number:

> The number 2 is a very dangerous number: that is why the dialectic is a dangerous process. Attempts to divide anything into two ought to be regarded with much suspicion. I have thought a long time about going in for further refinements: but in the end I have decided against. I was searching for something a little more than a dashing metaphor, a good deal less than a cultural map: and for those purposes the

> two cultures is about right, and subtilising any more would bring more disadvantages than it's worth.
>
> (Snow, 1964: 9)

The author concurs with Snow about the danger of the number '2' because attempts to divide phenomena in our temporal existence into two irreducible, irreconcilable dualistic essences is oversimplified. This essay is not just focused on a philosophical debate of dialectics and dualism (incommensurability of two polar extremes); it also leads to the thesis of an alternative non-Occidental view of monism (unity of two opposite essences). In the final analysis, with respect to the monistic Eastern worldview of science, perhaps the number '1' is an even more dangerous number than '2' because it incapacitates our natural tendencies to divide reality into irreconcilable polar opposites. The monist worldview suggests a somewhat incomprehensible unity between ostensibly irreconcilable polar extremes; for example, male and female, science and the humanities, being and non-being, and the natural and supernatural domains. Perhaps most of all, the monistic worldview confronts all individual human beings with what we are naturally averse to admit – the demand to unconditionally submit/surrender/submerge individual agency to/with the transcendental/immanent, collective universal 'divine' will (whether Personal or impersonal, as respectively demanded in monotheistic Abrahamic Judaism, Christianity and Islam, or in polytheistic/pantheistic Hinduism and Buddhism, and the so-called naturalistic, 'animistic' faiths.)

Theoretical Foundations

The said Japan Foundation-sponsored Intellectual Exchange Project (IEP) is theoretically anchored in Kawasaki's (1996) key concept of language-culture incommensurability (LCI). The theory of LCI starts of with the observation that the English language as a "Standard Average European' (SAE), is the dominant language of science around the globe. Next, Kawasaki emphasizes that the English language, as with all other SAE languages has a Platonic essentialist base. In other words, all absolute concepts of science, for example, mass, space and time, goes beyond to the reference to our imperfect, impermanent, temporal material world but transcends to a higher order metaphysical, unchanging, immutable pure world of essences. In this respect, the absolute essentialist concepts of science, as practiced globally, can be found in the 'king' of the sciences – positivist and theoretical physics which is much grounded in mathematical equations of positivist scince, where the objects of science, for example mass (m), acceleration (a) or force (F) are purely theoretical, rather than material objects. In the light of quantum mechanical physics, the old absolutes of classical mechanics – space and time – have been demolished. About the only absolute that is left is science is probably the speed of light, but even that is under review as physicists ponder the question of *what if* the speed of light can be reduced or exceeded.

Methodology

As conceptualized and implemented under the IEP workshop, a total of 50 science education experts from Southeast Asian countries – Malaysia, the Philippines, Myanmar, Thailand, Indonesia, Brunei, and Vietnam, including one from Australia (considered as an 'adopted' country within the greater Southeast Asian community) were invited to

participate in a workshop-cum-seminar from October 3 to 5, 2005, facilitated by the author in the capacity as project director.

In the IEP workshop, 3 keynote addresses and 5 country reports (Malaysia, Thailand, Myanmar, the Philippines, Australia) were presented. The workshop facilitators guided invited country participants to analyze language-culture incommensurability between original scientific terms written in English and translated terms in indigenous Southeast Asian languages. At the end of the workshop, the results were analyzed and interpreted. The proceedings of the workshop has been published in the IEP workshop proceedings (Loo and Sarmiento, 2005).

Findings of the IEP Project

For the purpose of this essay, the author only highlights language-culture incommensurability (LCI) in only one of the five Southeast countries involved in the project – Malaysia. The rationale for focusing on Malaysia is that Malaysia is perhaps the most culturally-diverse country in Southeast Asia that represents the entire spectrum of LCI.

Malaysia is a cultural melting pot formed from an ex-British colony. Before the colonial period[3], the population of Malaysia consisted primarily of indigenous races, the majority of whom were of Malay origin. During the colonial period, the British encouraged mass immigration of 'non-indigenous' people from China and the Indian sub-continent to provide labor for the colonial economy. Interestingly, the native Malays converted to Islam, a religion that originated from the Middle East that is geographically separated and hence not indigenous to the region. On the other hand, the vast majority of the non-native Chinese and Indians of Malaysia adhere to the faiths of Buddhism and Hinduism respectively – faiths that originated from India that in the early part of the first millennium dominated the Far East and Southeast Asia and thus can be considered as indigenous to the region before the advent of Islam.

Because they formed a large minority of the population, the Chinese and Indians successfully asserted their demands for mother-tongue instruction in government-aided schools. Until today, there are three types of government-aided junior schools in Malaysia – SK or *Sekolah Kebangsaan* (where the medium of instruction is Malay), SJKC or *Sekolah Jenis Kebangsaan Cina* (where the medium of instruction is Chinese), and SJKT or *Sekolah Jenis Kebangsaan Tamil* (where the medium of instruction is Tamil, the dominant Indian dialect in Malaysia). Up to 2003, the teaching of science and mathematics in junior school was based on the use of only three languages – Malay, Chinese and Tamil.

In a major curriculum policy decision implemented in 2003, vernacular instruction in science and mathematics at all levels of the Malaysian education system[4] will eventually be replaced by the sole use of the English language. The phased implementation of the policy began in 2003 in Year 1 of junior school, Year 1 of high school and Year 1 Form 6/matriculation. At the time of writing (2006), the use of the English language as the sole

[3]Malaysia is formed from two former British colonies – West Malaysia or Malaya and East Malaysia that consists of the states of Sabah and Sarawak. For West Malaysia, the colonial period lasted from 1786 to 1957. For East Malaysia which joined the enlarged Federation of Malaysia in 1963, the colonial period lasted from 1841 to 1963.

[4] Malaysia's education system is divided into 6 years of junior/primary schooling, 5 years of high school/secondary school education, and 2 years of pre-university level Form 6/matriculation education.

medium of instruction for science and mathematics has reached Year 4 of junior school and Year 4 of high school. It has also been fully completed at the pre-university level and implemented up to the second year of first degree programs.

At the time of the IEP workshop (2005), however, four languages were still used in the teaching of science and mathematics in junior school – English (Year 1 to Year 3) and the non-English tongues (Malay, Chinese and Tamil for Years 4 to 6). This created an ideal situation to explore LCI concerning the concepts of 'nature' and 'observation' in science.

The following sub-sections report the findings of the IEP workshop.

Language-Culture Incommensurability Concerning 'Nature'

Language is not only a means of communication; it is also a bearer of culture. If that is the case, the fundamental problem of science education, the author asserts, is too much is assumed when scientific terms in the dominant global language of science (English) are translated into native tongues for the purpose of instruction. What may be lost in translation are diverse cultural expressions that are erroneously assumed to be equivalent when verbalized in diverse spoken and especially written language codes.

Take for instance, the term 'nature' which forms the focal point of the scientific endeavor – to generate rational and empirical knowledge that enable us to understand and solve problems pertaining to the temporal world of physical objects and phenomena that surrounds us.

Perhaps the most comprehensive analysis of the dominant Occidental concept of nature was given by R.G. Collingwood (Collingwood, 1945). According to Collingwood, the Occidental idea of nature can be understood when it is divided into three historical phases.

The first and earliest Occidental concept of nature was born in the pre-Platonic era of Greek cosmology anchored in a holistic, organismic, vitalistic and teleolistic view of nature that is "not only alive but intelligent … with a 'soul' or life of its own … a 'mind' of its own." (Collingwood, 1945: 3). Collingwood's description has found modern expression as the *Gaia* hypothesis of the New Age movement. *Gaia* was the Greek earth goddess; the *Gaia* hypothesis suggests that the entire physical universe (including the earth and all life forms within it) should not be divided into individual, discrete parts but should instead be understood as a whole – a unified, *immanent*, intelligent being that is alive – that moves towards a single, intelligent end purpose. The ancient Greek organismic view of nature has its parallels in contemporary Eastern civilizations, for example, the pantheistic Hindu concept of 'Mother' India that emerged in the Aryan civilization of the Indus Valley.

The next Occidental concept of nature that emerged originated in Plato's antithesis to the organismic hypothesis that found full expression in the Newtonian classical mechanical worldview during the Renaissance. The central point of the Newtonian mechanical worldview is the 'denial that the world of nature, … is an organism, and the assertion that it is devoid of intelligence and of life"; it rejects the notion that nature moves with an intelligent purpose but responds mechanically to "laws of nature." (Collingwood, 1945: 5). In short, nature from the mechanistic viewpoint is analogous to a non-living machine, the functions of which can be demystified into positivistic scientific laws by living human observers. Initially, Early Renaissance thinkers gave due acknowledgment to the *transcendent* role of God as maintainer of nature after Creation but this became less and less important as the universe was increasingly 'shown' to seemingly function like a clock and 'obey' the impersonal, mechanical laws of nature

(Loo, 2001). By the time of the Enlightenment, Western science seemingly reduced God to god-of-the-gaps, whose power covers a few yet uncovered gaps in our understanding of nature which would eventually be filled up by the certitude of mechanical science.

At the turn of the 20th century, the certitude of classical mechanics collapsed in the wake of a new form of mechanics – quantum mechanics – a branch of mechanics that began in the study of discrete measures of energy but eventually developed into the study of the mechanics of elementary particles of matter. The strange behavior of particles in the sub-atomic world of nature that defied the powerful predictive laws of classical mechanics could finally be understood in the probabilistic laws of quantum mechanics grounded in Heisenberg's Uncertainty Principle. Classical mechanics pertaining to the world of 'big' mechanical objects is now recognized as falling short of certainty. All classical mechanical laws can now be rewritten as probabilistic quantum equations. Ironically, the new physics of elementary particles gave new insights to revitalize a branch of science that had long existed at the fringe of science for want of empirical evidence – cosmology, the science of the 'biggest' objects. Without the support of ground breaking developments in the quantum theories of matter, the Big Bang theory, the most widely accepted current model of the origin of the universe, would have remained nothing more than pure speculation. The marriage between quantum physics and cosmology yields what Collingwood refers to as the modern view of nature. The modern view of nature contrasts with two previous views – nature as a snap-shot of an organism with vitalistic functions and teleological purpose, and nature as a snap-shot of a machine with mechanistic and non-teleological purpose. In both the earlier said views, nature is treated as changeless. In Collingwood's modern view, nature is an evolving, constantly-changing cosmological whole that reflects new Western philosophical and cosmological thinking in science. Collingwood's modern evolutionary view of nature, which while not necessarily moving according to absolutely certain scientific laws, nevertheless appears to evolve to fulfill some form of teleological design – a cosmos that has a evolutionary process in between a finite beginning and an end.

The mechanical worldview is a dualist view of nature with God taken out of the picture where the ideal positivist laws of science in fact reside in a world of Platonic essences. Although such scientific laws fall short of full physical realization in the world of shadows (the physical world), they undeniably provide useful solutions to many problems pertaining to our physical existence.

Notwithstanding Collingwood's modern Occidental idea of nature, the author argues that the dominant language underlying discourse and instruction in science – the English language – is still grounded in the worldview, culture and cosmology of the old mechanical idea of nature. In schools all over the world, the old mechanical idea of 'nature' as expressed in the English language still applies in the teaching of school science. Children in school all over the world are still taught about the old essentialist absolutes in junior and high schools, for example matter has mass and occupies space. Also, curriculum material on mechanics is still presented in school as though space and time are absolute.

In the IEP study, as explained earlier, four languages are currently used at various levels of junior school in Malaysia for the teaching of science – Malay, Chinese and Tamil.

Firstly, consider the Malaysian Malay idea of nature. As explained earlier, all Malays, the dominant ethnic group of Malaysia are Muslims. The Malay concept of *alam* rooted in monist and dualist Islamic cosmology.

Where monist Islamic beliefs are concerned, the most fundamental concept of Islam is *tawhid.*– the singular, unifying belief that there is only one God and the one God bears

the name of Allah. Abusulayman (1989) has extended the monist concept of *tawhid* to incorporate the sub-concepts of the:

1. Unity of Creation
2. Unity of Humanity
3. Unity of Truth and Knowledge
4. Unity of Life

On one hand, Malays who are Muslims adhere to a dualist notion of nature because Islam recognizes a separation between *alam* (the creation) and Allah/God (the Creator). On the other hand, taking the *tawhid* principle into consideration, all Malays in particular, and all Muslims in general, have a monist concept of nature. Thus, while there is a clear, unambiguous idea of an Almighty God who transcends, pre-existed, and created the following realities, nevertheless there exists unity and continuity amongst all the following created realms:

The spiritual world (*Roh* in Malay, *Rooh* in Arabic). In Islam, spiritual/metaphysical reality precedes the temporal physical reality created by Allah. References to the ultimate, perfect world that pre-existed everything can be found in the verses of the following Qur'anic *surah* (book):

> *Yawma yaqoomu a**l**rroohu wa**a**lmala-ikatu saffan la yatakallamoona illa man athina lahu a**l**rrahmanu waqala sawaban*
> (*trans.*: The day on which the spirit and the angels shall stand in ranks; they shall not speak except he whom the Beneficent Allah permits and who speaks the right thing.)
>
> *(Surah 78:38)*

The world of physical matter (*Dunia* in Malay, *Dunya* in Arabic) The world of temporal physical reality that Muslims believe was created by Allah is clearly identified in the following *surah* verses:

> *Bal tu/thiroona alhayata alddunya*
> (*trans*: Nay! you prefer the life of this world)
>
> (*Surah* 87:16)

The intermediate world (*Barzakh,* both in Malay and Arabic). Muslims believe in an intermediate world that exists after the end of the temporal physical world (*dunia*) and before the emergence of the after-world (*akhirat*). The intermediate world may be compared to the Catholic Christian concept of purgatory, as suggested in Dante's *Divine Comedy.* This belief is founded upon the following *surah* verses:

LaAAallee aAAmalu salihan feema taraktu kalla innaha kalimatun huwa qa-iluha wamin wara-ihim barzakhun ila yawmi yubAAathoona
(*trans.*: Haply I may do good in that which I have left. By no means! it is a (mere) word that he speaks; and before them is a barrier until the day they are raised.)

(*Surah* 23:100)

The after-world (*Akhirat,* both in Malay and Arabic). The world that Muslims believe that emerges after the temporal physical world ceases to exist is highlighted in the following Quranic *surah* verses:

Waal-akhiratu khayrun waabqa.
(*trans:* while the hereafter is better and more lasting.)

(Surah 87:17)

Secondly, consider the Malaysian Chinese concept of nature. Unlike the Malays whose thinking about nature are influenced by the monist/dualist influence of Islam, the Chinese have a clearly monist idea of nature. Perhaps it is necessary at this stage to explain a bit about Chinese script. All languages are unavoidably essentialist, i.e., any spoken or written human language code inevitably dualistically separates 'sense' from 'non-sense'. In this respect, when people of Chinese origin evoke terms like 'male' and 'female', such terms refer to the shared world of sensory experience of all human beings where all human beings are artificially grouped into apparently clearly distinct gender classes, despite empirical evidence that denies such an absolutely convenient division. Nevertheless, the Chinese script, unlike romanized scripts, is based not on symbols but pictures. Every Chinese 'word' can be described as a pictogram that not only describes a monist unified picture but incorporates many pictures within one picture.

Take for example, the Chinese 'word' that is equivalent to the English word 'listen' – (*tīng* or 聽) which is perhaps the most noble of the five senses according to the Chinese. *Tīng* consists of many pictures within one picture. It combines the pictogram for the ear (*ěr* or 耳) with a noble Confucianist scholarly virtue (*dé* or 德) often associated with kings (*wáng* or 王) who are supposed to hear the voices of the masses and rule with a heart (*xīn or* 心). Most Chinese 'words' are not only pictures within pictures but join one picture with another. For example, the word for 'suicide' in Chinese consists of a meaningful prefix *zì* or 自 (literally, self) joined with a meaningful suffix *shā* or 殺 (literally, kill); thus suicide is an act of 'self-killing'. However, not all suffixes in binary Chinese terms carry meaning – some suffixes are only for phonetic purposes.

The Chinese concept of nature is expressed in the 'word' *zìrán*, written as 自然. It is the first part of the binary monist script, *zì* (自), that carries meaning; the suffix *rán* is largely for phonetic purposes although it suggests a connection to temporal material reality. The term *zìrán* encapsulates the curiously contradictory idea of a creation without a creator – in other words, a spontaneously, self-generated, temporal reality that was perhaps once unified within the ancient Taoist concept of *tiāndì* (天地) which literally means a merger between heaven and earth.

Merging current and ancient Chinese worldviews of nature, the Chinese have a monist idea of nature that like Malays does not separate natural and supernatural reality. However, the Chinese seem to believe in the concept of a self-generated reality, a creation that *apparently* does not necessitate the role of a divine life form. This is perhaps encapsulated in the legend of one of most well-known Chinese folklores of cosmogony – the tale of Pángǔ (盤古) – the Chinese version of the Big Bang theory, so to speak.

According to the legend of Pángǔ, in the beginning the whole universe was contained inside an egg. Inside the egg, Pángǔ slept. When Pángǔ awoke, he took an axe and cracked open the egg. The egg shattered. In the explosion, the light and bright part of the egg became the sky or heaven (*yāng*); the heavy and dark part, the earth (*yīn*). Fearing that heaven and earth would weld together again, Pángǔ stood up, thus separating the two, growing at a rate of 10 feet a day. His breath became the wind and clouds, his voice thunder and lightning, his left eye the sun, his right eye the moon. After 18,000 years, Pángǔ died. As his body rested upon the earth, his limbs and torso formed the landscape to the north, south, east, west and centre. His blood formed rivers, his veins became roads & paths, from his flesh fertile soil and trees were formed, hair on his head gave birth to stars, body hair yielded grass and flowers, his teeth formed metal and stone, and his sweat became the dew and rain. Finally, the lice on Pángǔ's body formed the first human beings.

Ultimately, the Chinese concept of nature is a monist concept where nature is inseparable from the supernatural domain. To make sense of the concept of 'creation without a creator', perhaps this is best understood and merged with Hindu and Buddhist pantheism, views originating from neighboring India that has much influenced Chinese thinking.

For this purpose, consider thirdly, the Malaysian Indian concept of nature as expressed in the Tamil dialect. Like the Chinese language, Tamil is a monist language reflecting pantheistic worldview of Hinduism. The Tamil word, இயற்கை (hiyarkai), expresses the pantheistic belief of Hindus in the immanent and omnipresent God. For Hindus, God is இயற்கை and இயற்கை is God.

Taking together Sino-Indian beliefs about nature founded on Hinduism and Buddhism, it suggests that the supernatural and natural domains are inseparable, i.e., a unified, monist whole. The supernatural realm does not transcend the physical world but pervades throughout the universe in the form of the divine immanent presence. This contrasts with the dualist view of nature of Occidental science without God in the picture and the Malay/Islamic view of nature with God in the picture.

Language-Culture Incommensurability Concerning 'Observation'

The Occidental concept of scientific observation is anchored in the philosophical principle of ontological objectivity. Ontological objectivity, like the idea of 'nature', is a dualist concept that demands the total detachment, uninvolvement or separation between the 'observer' and the 'observed'. In this sense, the human observer must detach himself/herself from the 'picture', not with respect to physical distance but also in terms of expunging all forms of social, cultural, political, religious influences – in short, any form of humanistic biases – that may interfere with the objectivity of observation.

In comparison, LCI is manifested in the Malay, Chinese and Tamil equivalents for the word "observation' that is used in school science textbooks in Malaysia.

The Malay word for 'observation' is formed from the root word (*hati*) with double prefix (mem + per) and suffix (kan) as follows:

mem + ~~p~~er (*hati*) + kan = *memerhatikan*

Hati in the Malay language in certain contexts refer to the physical liver but is more widely used with reference to the heart – not the physical heart but the emotional heart. Thus, *memerhatikan* is monist coded word meaning "to observe with one's heart".

For the Chinese, when a person observes (*guānchá* or 觀察) he/she is not emotionally detached from what is observed but instead appreciates and cares for what is

observed. Similarly, the Tamil term *uttru arithal* or உற்றறிதல் is grounded in religious values.

Clearly the Malay, Chinese and Indian terms for observation are monist-coded terms grounded in the spirit of *participatory observation* that are incommensurable with the dualist scientific term in the English language based on *detached*, objective ontological observation.

Conclusions and Implications

Philosophy, cosmology and language-culture incommensurability (LCI) in science

Perhaps the fundamental difference between the philosophy and cosmology of Occidental and Oriental civilizations resides in language code. Language is not only a means of communication. Language is the means by which every civilization passes on culture and systems of expression of thought unique to a particular culture to the next generation.

By and large, the very process of cognition itself which subsequently impacts upon language is unavoidably dualist, i.e., when thought and cognition are verbalized and articulated in the form of language, inevitably every word in any language coercively creates orderly classes from seemingly chaos – it artificially creates a foreground from a background. The English language, as the scientific language of instruction in Anglo-Saxon societies, performs an enculturation function that socializes individuals into a cosmological worldview dominated by essentialist philosophical thinking.

The findings of the IEP workshop shows that it is a grave oversight to assume that when scientific terms written in the English language are translated into other languages for the purpose of school science instruction, such terms carry the same meaning. In particular, 'nature' and 'observation' are crucial ontological and epistemological scientific terms based on dualist philosophy and cosmology that underlie the scientific enterprise. When such terms are translated into monist-coded languages like Chinese and Tamil, science learners in the East may not share the same understandings as their Western counterparts.

Occidental scientific philosophy has largely removed the human context from the content of science. Even well-regarded contributors in the history and philosophy of science like Michael R. Matthews who promote a liberal HPS (history, philosophy and science) approach to science education and accept the notions of cultural relativism and culture-in-science because of the long cultural patronage and association between science and Western society, nevertheless insist that the 'scientific landscape' is characterized by the "three Rs – Reason, Realism and Rationality" (Matthews, 1994: 9).

The alternative non-Occidental, Eastern perspective suggest that 'nature' and only be understood and 'understood' with the added element of the often neglected human heart (the missing H), the voiceless voice of human intuition that has and had always been at the forefront of the scientific enterprise when the giants of science like Copernicus, Newton, Darwin and Einstein managed to break free from the iron cages of accepted conventional human reason, realism and rationality to listen to the voiceless universal voice of the intuitive heart to generate radical, cutting-edge paradigmic revolutions in science to lead us to the science that we know today.

By no means do the findings of the IEP study suggest that the scientific understanding of learners in the East is flawed.

Science, according to renowned historians of science, is a universal heritage of all humanity. However, the vast weight of the globally-recognized academic and intellectual literature on how science has progressed throughout history has apparently focused on the premise that the seed that paved the way towards the science we know today, was sown in ancient Greece. This premise is best exemplified by Sarton (1952). Nevertheless, Sarton acknowledges the debt owed not only by Occidental civilizations but also all humanity to the contributions civilizations that preceded Greece and Rome (for example, Mesopotamia, China and India) as has all more recent well-known intellectuals in the history and philosophy of science, for example Matthews (1994: 192), who concedes that the "history of science shows how dependent European science has been upon the achievements of non-European cultures".

Nevertheless, the acknowledgment of the debt that the 'West' owes to the 'East' comes to an abrupt halt at the level of epistemological considerations, for example, Matthews's (1994) rejection of the multi-science thesis and the thesis of multiculturalism in science on epistemological considerations. Matthews rejects the said theses on the basis that if alterative scientific doctrines like the Stalinist-sponsored Lysenko's application of Lamarckian evolutionary theory and the Nazi Aryan master race-inspired eugenic science have been eventually discredited and falsified, therefore alternative indigenous epistemologies of science are doomed to suffer the same fate:

> Before climbing into the multiscience bed, or jumping on the multiscience bandwagon, educators and others ought to be cautious and look carefully at who else is in the bed or aboard the wagon. Some bedfellows or fellow-travellers are unsavory. This is not the unworthy accusation of guilt by association. The cautions has its forces because the unpalatable fellows are sanctioned by the core of the multiscience doctrine.
>
> (Matthews, 1994: 197)

This essay goes beyond epistemological considerations. As the grand conclusion that ramifies towards implications for scientific practice and education, the author requests the reader to ponder the end of the journey of Occidental science. Occidental science comes to an abrupt halt as delimited by the furthest limits of human reason and sensory experience. Beyond those limits, we find ourselves in the non-science domains of teleology and religion – worlds beyond and apart from 'nature' which suggest some kind of supernatural role beyond temporal reality.

The monist Eastern perspective is most relevant at the very extreme edge of science – quantum mechanics and modern cosmology where scientists and philosophers are increasingly reduced to an attempt to reasonably explore our physical universe without empirical verification.

Absolute essentialist concepts like the concept of 'matter' break down because matter at the sub-atomic level does not have immutable existence in absolute time and space. Instead, physical objects appear to exist as impermanent, ever-changing entities that merge, disengage and remerge in a singular reality in a 'cosmic dance', so to speak. Within the limits of scientific technology (for example, elementary particle accelerators),

space and time can be warped to enable scientists to study of the behavior of elementary particles. However, the sheer financial cost limits the scope of the empirical verification of quantum mechanics and brings us very close to the end of science – science reduced to reason without empirical verification. Nevertheless empirical quantum mechanical repeats of Young's double-slit experiment of the particle-wave dual property of light and non-empirical thought experiments like the Aspect experiment lead us to either accept the possibility of 'spooky action at a distance', or alternatively accept the unreasonable notion of intelligent, unified physical particles that are not only alive but appear to be able to communicate instantaneously across infinite space-time – in short, inseparable entities within a grand unified whole – supernature-nature. Of course, the world of the supernatural is beyond science but, on the other hand, the same may be said of cutting-edge quantum mechanics and cosmology.

On this basis, this essay concludes that there are two cultures of science – one based on Occidental dualist philosophy and cosmology, and the other on non-Occidental monist philosophy and cosmology. Both cultures of science are relevant to science and science education. In the final analysis, due attention should be given to Eastern view to enrich our understand of the world around and beyond us, projecting beyond the limits of reason and physical experience.

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Toward Restoration of Subjectivity in Science Education: How to Resolve Language-Culture Incommensurability

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Summary: This article focuses on conflict, which science education inevitably entails in non-Western nation-states. Although each nation state praises for its language-culture tradition, which is particular, science education in non-Western nation-states inevitably make an implicit assumption that Western Modern science is universal. The conflict between the particularity and the universality appears to be language culture incommensurability, which causes conceptual confusion about scientific concepts in pupils' mind. However, those science educators who accept the universality of science are inclined to regard pupils' conceptual confusion as setbacks on their learning. Then, it becomes unattainable for science educators to identify the cause for pupils' conceptual confusion. The present article discusses how to illuminate the language culture incommensurability with the aid of anti-essentialism, of which outline is also given. Furthermore, proposing the axiomatics model of cognition, this article develops how to resolve the language culture incommensurability. The resolution will form pupils' restoration of subjectivity suppressed in science education in non-Western nation-states.

Introductory Remarks

Historically, science education, i.e., teaching Western modern science, stems from formation of nation-states, a way of organizing people. In the West Europe in the late eighteenth century the conception "nation-sate" was coined on the basis of nationalism. Till then, people had been organized into "dynastic or religious states, tribal agglomerations or supranational empires" (Kohn 1973, 324). Nation-states had a new manner of organizing people, and all most all states organize themselves into nation-states in the present time.

There the people cease to be more passive objects of history; consequently, nation-sates satisfy the following three conditions:

1) self-determination of the life of the group.
2) introduction of modern science and technology in the service of the nation.
3) exaltation of the national language and traditions above the formerly frequent use of universal languages (in Europe Latin and later French) and universal traditions (Christianity or Islam). (Kohn 1973, 324)

The first condition is the most fundamental feature of nation-states, and is a paraphrase of "the people cease to be more passive objects of history" in the foregoing.

The second condition advocates science education in each nation-state, which wishes to establish an industrialized society in the nation-state. With the national intention of

establishing an industrialized society, each nation state stresses science education. The third one proclaims the privilege of the national language in each nation-state, and aims at nurturing language-culture identity in people's mind. In other words, this states that priority should be given to "particularity" over "universality." In the following "Western modern science" is abbreviated to "W-science" as in Kawasaki (1996) which implied that W-science is the Western indigenous or ethno-science. In addition, the modifier "language-culture" is abbreviated to "LC."

A conflict inherent in non-Western[11)] nation-states arises as to the second and the third conditions. The second one encourages non-Western nations to conduct science education that can establish highly industrialized societies as stated above. This directs non-Western nations' attention only to decides what W-science ought to be: a people's outlook on W-science, i.e., institutionalized or socialized view of W-science (Kawasaki 1996). As a result of the institutionalized view of W-science, whenever science educators consider science education, they are sure to take into account of improving technology to a certain degree. Since the idea of industrialized societies is common to the whole world, this institutionalized view willingly finds and accepts the universality in W-science.

This outlook on W-science is normally shared in nation-states although the outlook may not reflect the genuine nature of W-science correctly. For instance, from a historical point of view, W-science had not been effective for improving technology until the late nineteenth century (Fuller 1997, 103). This implies that W-science and developing technology had independently progressed, because W-science had acquired its essential nature since the scientific revolution in the seventeenth century. Apart from whether the outlook stressing the idea of industrialized societies reflects the genuine nature of W-science, the second condition leads people to give a higher regard for "universality" than for "particularity" in science education.

Actually, science educators always place special emphasis on this universality of W-science in order to encourage pupils to learn W-science. In non-Western nation-states, this definitely contradicts the third condition stating that priority should be given to particularity over universality. There, it is taken for granted that W-science should be taught. As a result, it becomes difficult for science educators to realize that W-science acts as the universality in the science classroom and that the non-Western language culture particularity tends to be depressed for accepting W-science. In order to investigate and resolve this dilemma, it is significant for distinguishing science education conducted in non-Western nation-states from that in Western nation-states.

In Western nation-states, praising the universality of W-science is consistent with the third condition because this universality stems directly from the particularity of the Western cultures (Kawasaki 1996), which identifies itself as the legitimate successor to the Greco-Roman civilization. By contrast, the particularity of non-Western cultures cannot connect the tradition of the Western culture. Thus, in non-Western nation-states, those science educators who carry out science education ought to take into account of the cultural difference in what the combination of the second and third conditions brings about in the science classroom. For instance, science education assists in pupils' nurturing LC identity in Western nation-states, but it prevents pupils from nurturing LC identity in non-Western nation-states. Unfortunately, very few science educators are aware of this

[1] In this article, I distinguish "non-Western" from "Western" by adopting a linguistic criterion, which Whorf (1959, 214) proposed as "Standard Average European" abbreviated to "SAE." The notion "SAE" stands for English, German, French, etc., between which differences are insignificant against differences in Asian, African, Polynesian, etc. languages (for details, see Whorf 1959, 214). This makes it possible to articulate the Western culture and to compare it with the Japanese culture (see Kawasaki 1996). The present article refers to English as a representative of SAE.

conflict; they focus only on the social function of science education: advancement of industrializing the society.

Science educators have to resolve this dilemma. Science education has to make continued progress in industrialization: this focuses on the universality. At the same time, science education has to nurture pupils' LC identity: this focuses on the particularity. How to resolve the dilemma is a critical issue that needs to be discussed in non-Western nation-states. Considering Japan to be a typical non-Western nation-state, Kawasaki (2002) clarified the dilemma in a comparative study between the Western and Japanese worldviews, and coined the conception "language mode of science education" (see Chapter 3), in order to reveal difference in language-culture setting for science education between the LC communities. This conception will remind science educators of what science education brings about in non-Western nation-states. The present discussion is partly based on Kawasaki (1996; 1999; 2002).

In this chapter I will adduce examples of LC incommensurability, LCI, with respect to "nature" between the English and Japanese LC communities. The examples will reveal that, although the belief in the universality are inclined to conceal the dilemma, science educators are really confronted with the dilemma in the science classroom. The examples will help science educators take the first step to make an epistemological endeavour to grasp it for correct teaching of W-science in non-Western nation-states.

In the next chapter, I will introduce structural linguistics, a kind of anti-essentialism, which offers a philosophical base for developing the present discussion. In Chapter 3, a comparative study between the English and Japanese worldviews will be briefly described. Then, the notion "language mode of science education" will be introduced form a relativistic view about science education and science education research. This notion will make it possible for science educators to differentiate science education with respect to language culture setting for it. Finally, I will propose an axiomatic description of science education in Chapter 4 (this part is cited from International Journal of Science and Mathematics Education). By means of the axiomatic description, it becomes possible to conduct comparative studies between various language modes of science education. Furthermore, the axiomatic description will assure restoration of subjectivity in non-Western language modes of science education. This means the dilemma of the second or the third conditions is resolved.

Language Culture Incommensurability in Translation

Language-culture incommensurability, LCI, is always associated with translation of a language into another language. Because LCI is a trans-LC phenomenon, researchers need to ensure equitable treatment of the two LC communities in their research on it. If researchers are careless of ensuring the equitable treatment, they unwittingly hold a biased viewpoint favourable toward one of the LC communities, and judge each LC community to be right or wrong according to the biased viewpoint. Because science educators tend to have a biased viewpoint toward W-science in the context of science education, they have to be careful not to judge a specific non-Western LC from the biased viewpoint toward W-science. Only those science educators who are careful not to judge will ensure the equitable treatment.

As is well-known, Japan as a new born nation-state experienced an encounter with W-science in the second half of the nineteenth century. Then, Japan started arranging science education; this was a national endeavour to fulfil the second condition for nation-states. On that occasion all W-scientific concepts were completely unfamiliar to Japanese

people, but at any rate they had to express W-scientific concepts in Japanese terms. In the expression, 1) some Japanese terms were newly coined, and 2) W-scientific concepts were assigned to Japanese terms, which had been present in the Japanese language. In both cases, these Japanese terms believed to be equivalent to W-scientific concepts inevitably involve LCI in the context of science education.

The first type of LCI

An example of LCI in the first case, the first type of LCI, is found in the Japanese term "shitsu-ryo" science educators believe to be equivalent to "mass" in the context of physics and science education, of course. This Japanese term is a hybrid of *shitsu* and *ryo* both of which had been already present in those days of translation. A possible English equivalent of the Japanese term *shitsu* is "quality," and that of *ryo* is "quantity." The two Japanese terms have meant to be different evaluation bases as the following example shows: Today's special is sufficient in quality but insufficient in quantity. Japanese pupils, who first find the hybrid term *shitsu-ryo* in the science classroom, cannot construct the whole meaning only from the respective concepts of *shitsu* (quality) and *ryo* (quantity). This strongly implies that it is impossible for science teachers to explain the concept in terms of the pupils' LC experience gained in their daily life. The pupils have to accept *shitsu-ryo* as something significant but different from *omosa* (weight) the pupils really experience in their daily life.

It may also be difficult for pupils, whose first language is English, to distinguish "mass" from "weight" in the science classroom. However, they have the way to grasp the Newtonian usage of "mass" because the Newtonian usage is definitely connected to the traditional usage of Western langauges in some way. For example, the Oxford English Dictionary gives the following explanation, which dates back to the fifteenth century: a coherent body of plastic or fusible matter. A problem particular to Japanese pupils is that the hybrid term makes it impossible for them to construct the concept of *shitsu-ryo* within their LC tradition they really experience. However, if science teachers were enough careful to realize the difference in LC setting between the West and Japan, the first type of LCI would not be more serious than LCI discussed in the following, the second type.

The second type of LCI

Suppose that translation equates a W-scientific term with a Japanese word, which has played a significant role in the Japanese way of thinking. Even though the Japanese term is expected to convey the W-scientific concept owing to translation, Japanese people still remember the traditional meaning. As a result such a Japanese term contains two types of meaning, W-scientific and traditional ones, pupils are forced to distinguish these concepts in the science classroom. The insulating power of the context (Lewis 1960, 11) seems to be effective in science education in non-Western nation-states, because, by exercising it, pupils can make the most adequate choice among concepts of the single word according to an actual context.

In the science classroom, science teachers unwittingly expect pupils to exercise the insulating power of the context and to recall the W-scientific concept only. In order to fulfil science teachers' expectation, however, pupils conceive the W-scientific context as different from their own LC context according to which they do their thinking. It is almost impossible for pupils to fulfil this condition. They are now learning both contexts; then, they cannot sufficiently exercise the insulating power of the context. The Japanese

word may remind pupils not of the W-scientific concept but of the inherent concepts even in the science classroom. This is the result of the second type of LCI.

Furthermore, science teachers tend to place special emphasis on effects of W-science on pupils' daily life. The emphasis may result in pupils' failing to distinguish between them. Although science educators are inclined to regard the emphasis as an effective strategy for arousing pupils' interest in studying science, the emphasis necessarily includes the problem that confuses W-scientific context with pupils' LC context. The Japanese expression of W-scientific concepts definitely reinforces the confusion. This problem is usually overlooked by science teachers in non-Western countries.

As a rule, essential meaning seems to be lost and extra meaning is attached in translation. In other words, translation of W-scientific concepts into the Japanese language transforms W-scientific concepts into different concepts in accord with the Japanese LC context. Since W-scientific concepts are expressed in the Japanese writing system in the science classroom, Japanese pupils as well as science educators are rarely aware that these Japanese terms originate in a foreign language, where the original tem conveyed the original concept. Actually, this unawareness is the fundamental cause of LCI. If science teachers realized LCI, they would take a step to resolve LCI concerned. The only way to resolve LCI is the awareness of it. This is the reason why epistemological reflection is emphasized throughout this article.

Japanese Examples of the Second Type of LCI

In this section two typical Japanese terms are adduced as the Japanese expression involving the second type of LCI: *shizen* equivalent of nature and *kansatsu* equivalent of observation. Another significant Japanese term *jikken*, the equivalent of experiment, will be discussed in Chapter 3. Obviously, these three Japanese terms are key concepts, without which science education would be impossible in Japan. However, these examples will reveal that science teachers cannot convey to pupils the meaning "Let's conduct experiment with observation of nature" in saying "Let's conduct *jikken* with observation of *shizen*" in the Japanese language. Unfortunately, very few science educators realize this Japanese LC effect on science education.

Nature-Shizen

The first example of the second type of LCI is found in the Japanese term *shizen* science educators believe to be the equivalent of "nature," a generic name of natural things. This Japanese term had never been a meaningless word when it was translated from "nature" in the last period of the nineteenth century. Far from being meaningless, *shizen* had conveyed significant concepts of the Japanese religion and/or philosophy since around the sixth century. In that period Japan accepted the Chinese civilization, Confucianism, Buddhism and Taoism, written in Chinese characters. Since then, the Japanese writing system began forming itself.

The Japanese term *shizen* originated from the Chinese term *tzu-jan*. The term *tzu-jan* was coined in the third century B. C. in China, and the most possible English equivalent of it was "spontaneity" in the context of Taoism, the philosophy inherent there. By using this term, Taoists seemed to refer to "the Supreme Being." An archetypal usage of this term is found in *Lao-tzu* of which author is believed to be the founder of Taoism. The following is the last part of Chapter XXV of *Lao-tzu*.

> Man models himself on earth.
> Earth models itself on heaven.
> Heaven models itself on the Way.
> And the Way models itself on (its own) spontaneity. (Iizutsu 2001, 73)

Obviously, Taoism opposes *tzu-jan* to "Man," "Earth" and "Heaven" and also opposes "Man" to *tzu-jan*, "Heaven" and "Earth."

When the Chinese word *tzu-jan* came to Japan in around the sixth century A. D., its sound changed from *tzu-jan* to *shizen*. At the same time the Japanese term *shizen* transformed the original Chinese meaning into the meaning intrinsic in Japan. The translation Japanized *tzu-jan*. A noticeable feature of the Japanization is that *shizen* is regarded in the same light "Man," "Earth" and "Heaven." However, *shizen* continues to convey the meaning of "spontaneity" and "the Supreme Being." The combination of these two terms will readily suggest to Christian people the Creator's self-introduction to Moses:

> God said, "I am who I am. You must tell them: 'The one who is called I AM has sent me to you'…" (Exodus 3: 14)

The term "spontaneity" adequately describes the essence of "I am who I am." If the Creator had known the Japanese term *shizen*, He would have introduced Himself to Moses: I am *Shizen*.

Several centuries after the acceptance of *shizen*, Shinran (1173-1262), a Japanized Buddhist monk of the Pure Land School, called Tathagata Amida, the Lord of the Pure Land, *jinen* that is expressed in the same Kanji characters as *shizen*.

> As the essential purport of the Vow, [Amida] vowed to bring us all to become supreme Buddha. Supreme Buddha is formless, and because of being formless is called *jinen*. Buddha, when appearing with form, is not called supreme nirvana. In order to make it known that supreme Buddha is formless, ……. (Shinran 1997, 530)

Since difference in sound carries little significance in the same kanji expression, it can be understood that the Lord of the Pure Land acquires the name of *shizen*. The term *jinen* (= *shizen*) can still refer to "the Supreme Being." The reason why the Supreme Being is called *jinen* is that it is formless.

Shinran warned the faithful not to talk about *jinen* following the citation above, because *jinen* refers to "the essential purport of the Vow" that lies beyond the practical experience of ordinary people.

> After we have realized this, we should not be forever talking about *jinen*. If we continuously discuss *jinen*, that no working is true working will again become a problem of working. It is a matter of inconceivable Buddha-wisdom. (Shinran 1997, 530)

By talking about *jinen*, the faithful will understand that the Vow lies within the practical experience of ordinary people. This is a fatal misunderstanding of it.

In addition, Dogen (1200-1253) emphasized the other aspect of *shizen*, which is regarded in the same light as natural things. He was a Japanized Zen Buddhist and a contemporary of Shinran. He found Buddhahood in the essence of impermanence of

natural things. The changeable character of the phenomenal world is of absolute significance for Dogen (Nakamura 1993, 352). Dogen asserted:

> Impermanence is the Buddhahood. …… The impermanence of grass, trees and forests is verily the Buddhahood. The impermanence of the person's body and mind is verily the Buddhahood. The impermanence of the (land) country and scenery is verily the Buddhahood. (Nakamura, 1993, 352)

Dogen has taught Japanese people that Buddhahood reveals itself in the impermanence of everything. Then, every natural thing or phenomenon is readily paraphrased as Buddhahood, which is properly called *shizen*.

A definition of *shizen* was found in the preface to *Shizen-shin'eido*, a philosophy book written by Ando Shoeki, a doctor and philosopher in the mid-eighteenth century. His faithful disciple, Seiryoken-kakusen, contributed the preface:

> Regarding *shizen* I was taught: Although *shizen* lies beyond human ability to think, consider, weigh and measure it, yet appear signs of being done by *shizen*. They are called *shizen* also. Only after you clearly realize that it is absolutely impossible to think, consider, weigh and measure and that it is possible to perceive nothing more than the signs, you will be able to provide elucidation of *shizen*. (translated by the present author from Bito & Shimazaki 1977, 12)

This description of *shizen* accurately reflects its essential features originate form the Chinese philosophy: *Shizen* lies beyond human ability, and is spontaneity and identical to the Supreme Being. Thus, although *shizen* is transcendental, natural things as the signs to be done by *shizen* are perceptible to human sense organs. Therefore, they can be regarded in the same light as *shizen*. All example of *shizen* adduced in the foregoing are cited from religious and philosophical works during the period when Japan closed itself to the world.

The following examples of meaning *shizen* generates according to actual contexts are cited from literally works written by Soseki (1867-1916), one of the most distinguished writers in Japan. His life went on with Japan as a new born nation-sate that firstly opened to US in 1853. Although he was deeply influenced by the Western civilization, he did not adore it uncritically beside his contemporaries. Even in the present time very few Japanese people have such a mind critical to the Western civilization. He wrote his literally works in the Japanese language as the national language of Japan, and they have achieved popularity as national literature, i.e., "literature as a particular national possession, as an expression of the national mind as a means toward a nation's self-definition" (Wellek 1973, 83).

Interestingly, scholars in the field of study of Soseki regard *shizen* a key concept to understanding of all his works that were written in the early twentieth century. By the time he wrote his works, the translation of "nature" into *shizen* was accepted not only in science or science education but also in humanities: institutionalization or socialization of the translation. Therefore, present-day Japanese people may share *shizen*-meanings with Soseki; then, *shizen*-meanings in Soseki's literally works will reveal what *shizen* conveys.

The procedure for revealing actual meanings is as follows. First, the two novels, *Kokoro* and *Michikusa*, were focused on; they were written late in his life, during the period from 1914 to 1915. All sentences that include *shizen* are underlined in the novels. Second, English sentences corresponding to the Japanese originals are also underlined in the English translations. Some English sentences have English terms that show clear correspondences to *shizen* in the Japanese originals, and others do not. Those English

terms that show clear correspondences are means that *shizen* conveys in actual contexts. In order to grasp *shizen*-meanings, those terms are just re-translated from the English terms into the Japanese language without using the original term *shizen*.

The following is a part of the *shizen*-meanings collected through the procedure above; they appear in alphabetical order:

> already; as the result; circumstances; consequently; force of circumstances; had to do; inevitably; in time; intuitive; my conscience; my natural self; natural and necessary; natural goodwill; normalcy; present itself naturally; quite understandable; scene; so constantly; self-conscious; the fresh green world; therefore; was forced by circumstances. (see Kawasaki 1996)

Undoubtedly, these meanings stem from the single Japanese term *shizen*. English-speaking people would conclude that the Japanese term *shizen* must be confused in meaning, because this single term refers, for example, to "force of circumstances," "natural good will," "my conscience" and "the fresh green world" at the same time. Furthermore, knowing that science educators regard this term as the equivalent of "nature" in the science classroom in Japan, the English-speaking people would also judge that science educators must be wrong in having their pupils consider "my conscience" in the science classroom.

However, the English-speaking people will agree on one hand that the Japanese language is not confused being aware that *shizen* has referred to "the supreme Being," "something beyond human ability" and "natural things as signs being done by the supreme Being" in the Japanese LC tradition. On the other hand, they will disagree that science educators regard *shizen* as equivalent of "nature," which definitely lies within human ability in the context of W-science. If "nature" lay beyond human ability, W-science would never be possible. The Japanese term *shizen* leads pupils to experience something beyond human ability in the context of their daily life based on the Japanese LC tradition. At the same time, due to the translation, *shizen* compels them to experience something within human ability in the context of the science classroom. Because the Japanese LC tradition inevitably acts as the LC setting for science education, conceptual interaction must take place between concepts "within human ability" and "beyond human ability." This interaction is the conflict science education has included in Japan since the beginning. In other words, a basic problem science educator must settle is the problem of translation in non-Western countries.

As a rule, translation loses something essential from a foreign original and adds something surplus to the domestic term translated from the foreign original. In the translation of "nature" into *shizen*, for example, the conception "within human ability" is lost whereas the other conception "beyond human ability" is added. The most probable case that takes place in the science classroom in Japan is: science teachers instruct pupils to consider natural objects to be within human ability but to appreciate them because of being beyond human ability at the same time. It is critical that very few science teachers realize this conflict.

The reason why science educators have believed *shizen* to be the equivalent of "nature" in Japan is that both terms can refer to natural things. However, both terms are opposed to each other from the viewpoint of human ability. *Shizen* is beyond human ability but "nature" is within human ability. In order to prevent pupils from such conceptual confusion about W-scientific terms, science educators have to conduct epistemological reflection on these terms in non-Western countries. The epistemological reflection prevents science educators from being perplexed by translation. In the present

case of nature-*shizen* translation, for example, the epistemological reflection will begin with distinguishing "nature" from *shizen* in the respective LC traditions.

To observe or Observation-Kansatsu

The Japanese translation of *kansatsu* from "to observe" or "observation" is the second example of LCI between the English and Japanese languages. In the same way as the nature-*shizen* case, science educators have accepted *kansatsu* as the equivalent of "to observe." However, there definitely exists the LCI between these two terms as discussed below. In the consequence of the translation science educators have accepted, the Japanese phrase *shizen no kansatsu*, where *kansatsu* works as a verb and *shizen* does as its object, decisively differs from "to observe nature." Regardless of this difference between these two phrases, science educators have confirmed the equivalence without any suspicion in Japan.

The Oxford English Dictionary explains that the term "observe" consists of the prefix "ob" and the base "servare" as follows:

> The prefix "ob" means "in the direction of", "towards", "against", "in the way of", "in front of", "in view of" or "on account of";
>
> the base of this term "servare" means "to watch", "look at", "guard" or "keep".

Those people whose first language is the English language take for granted that, being observed, an object is set against the observer and then observed. In observation, the subject-object dichotomy is clearly established.

By contrast, the Japanese LC tradition has cultivated an opposed subject-object dichotomy in the Japanese phrase "*shizen no kansatsu*." Hashida[2], a professor of physiology at Tokyo Imperial University, gave an archetypal Japanese articulation of the subject-object dichotomy. He was an exceptional and distinguished science educator. In his education, he made a clear distinction between *kansatsu* and "observation." By receiving powerful stimulation from Western civilization, he cultivated his philosophy of *kansatsu* in order to accord with *shizen* as the object in the activity *kansatsu*; it should be emphasized that he never cultivated the philosophy of *kansatsu* in accordance with "nature." Throughout the philosophy of *kansatsu* he advanced this thought only within the realm of the Japanese LC tradition of philosophy.

Hashida, as a physiologist in the W-scientific sense, had formed a world view according to W-science, but his outlook on life was always in the context of Japanese culture. On the basis of his conviction that the worldview must agree with the outlook on life (Hashida 1940, 3), he claimed that *kansatsu* was superior to "observation" in watching and understanding the world and that *kansatsu* ought to be regarded as a

[2] According to Sugi (1970), Professor Kunihiko Hashida was born in 1882, a son of samurai lineage, and died in 1945. From 1914 to 1919, he went to Germany and Switzerland to study physiology. After coming back to Tokyo Imperial University, he gave a course in physiology and began to study *Shobogenzo* (正法眼蔵), Dogen's Essentials of the True Law. He was also appointed Minister at Monbusho, the Ministry of Education, Science and Culture, in 1940 and retired in 1943. He committed suicide by poison just after World War II; unfairly, he was accused of being a war criminal for the reason that he had been appointed, at the outbreak of the War, Minister of Monbusho (translated and summarized from the Japanese original). Until junior high school, he was educated not only in Western Civilization but also in Chinese classics, namely Confucianism and neo-Confucianism. Neo-Confucianism, in particular, cultivated the samurai virtue and spirit through the Tokugawa period (1603-1868). Since neo-Confucianism shows a Buddhist influence, it is understandable that he focused his attention on the philosophy of Dogen.

genuine W-scientific activity. Because of this superiority, he asserted the replacement of "observation" by *kansatsu*, and claimed an advantage of the Japanese science, the Japanese system of knowledge of *shizen*. Against the common opinion that Japan was behind in W-science, Hashida insisted that Japanese science was advanced in the activity *kansatsu* and that the Japanese science was superior to W-science. By insisting on the superiority, he seemed to cancel out the fact that Japanese science was totally behind W-science.

Apart from his unreasonable insistence on superiority, his thought on *kansatsu* clearly shows the innate meanings of it to the Japanese worldview. In the Japanese language this term *kansatsu* is so articulated that *shizen* is properly grasped in the activity of *kansatsu*. Until the days of Hashida, the first half of the nineteenth century, the Japanese term *kansatsu* had been accepted as the equivalent of "to observe" or "observation." Regardless of the translation, he did not overlook the genuine meaning of *kansatsu*, which typically characterizes the Bodhisattva *Kanzeon* (*Kuan-shih-yin*) in Buddhism, because he had cultivated his intelligence on the basis of the philosophy of *Wan Yang-ming* (1472-1528), a Chinese Confucianist of the *Ming* dynasty. The school of *Wang Yang-ming* closely related to Buddhism at that time in China. Through the relationship between Buddhism and the philosophy of *Wan Yang-ming*, science educators in Japan found what they subconsciously do in Hashida's thought on *kansatsu*. It should be emphasized that *shizen* can be neither perceived nor understood as shown in the foregoing.

Hashida's thought is highly beneficial for science educators' epistemological reflection on how the W-scientific concept "observation" has been accepted and Japanized. His thought on *kansatsu* can be related to the name of the Bodhisattva *Kanzeon*, which has the same *kanji*-character *kan* as the term *kansatsu* has (Kawasaki 1992). Since *kanji*-characters are ideograms in the Japanese writing system, the *kanji*-character *kan* means what the Bodhisattva *Kanzeon* is expected to perform to Japanese people. The meaning of this Bodhisattva's name traditionally has been understood in several ways, emphasizing his sovereignty over the material world and his responsiveness to the calls of suffering humanity. A principal interpretation holds that the Sanskrit name of this Bodhisattva, *Avalokitesvara*, is a compound of Sanskrit *avalokita* and *isvara*, translated variously as "the lord of what is seen, the lord who is seen" or "the lord who surveys, gazing lord."

The celebrated seventh-century Chinese monk-scholar *Hsuan tsang* upheld this view, translating the bodhisattva's name as *Kuan-tzu-tsai*, gazing lord (Birnbaum, 1987). Additionally, the two names are dedicated to this Bodhisattva:

> Kuan-yin: he who has perceived sound;
> Kuan-shih-yin: he who perceives the sounds of the world or hearer of the sounds of the world. (Birnbaum 1987)

In the foregoing the Chinese name *Kuan-shih-yin* is expressed by the same *kanji*-characters as *Kanzeon* in the Japanese writing system. Therefore, the possible English equivalents of *kansatsu* are "to gaze," "to perceive" and "to hear;" moreover, Nakamura (1993, 559) picks "to contemplate" as an English equivalent of *kansatsu*. The faithful have attributed the activity *kansatsu* to the Bodhisattva *Kanzeon*; the faithful never envisage themselves being isolated and observed by *Kanzeon*. This Bodhisattva's outlook on the faithful has determined the Japanese subject-object relationship. In this relationship, observers, more precisely gazers or hearer, have their empathy with what they are gazing or hearing.

The following citation from Aikenhead & Jegede (1999) will help English-speaking people to understand the difference between "to observe" and "to contemplate." According to Aikenhead & Jegede (1999), the following is originally found in Canadian Broadcasting Cooperation (1995).

> I watched the sunset over snow-capped summits of the coastal mountains, tuning slowly from white to pink, reflected in the calm ocean waters. As I was lost in meditation, a sudden thought broke my mood and wrenched me.... Since my last visit to the ocean, something important had happened. As a student in the physics department at the University of Montreal, some months earlier Maxwell's equations.... His equations provide us with an excellent mathematical representation of light's behaviour.... As I contemplated (underlined by the present author) this calm ocean, gloriously tinted by the setting sun, an inner voice spoke, "These designs, these forms, these shimmering hues, are the mathematical solutions to Maxwell's equations, perfectly predictable and calculable, nothing more." Within, I panicked. I feared that the exquisite pleasure I had enjoyed would simply dissipate.... Maxwel1's equations ... cancelled out, it seemed, the fragile magic of the rose tinted sky and iridescent sea. Shaken by this quandary, I tuned my back on a panorama I could no longer bear, and walked home….

Obviously, Aikenhead & Jegede (1999) intended to illuminate a poetic heart that collided with the W-scientific mind. As is shown in the forgoing, "to contemplate" is no way compatible with "to observe" in the English language. Different subject-object relationships are respectively supposed.

The philosophy of Hashida is an endeavour to formulate the similar subject-object relationship as supposed in "to contemplate" in the context of W-science. He asked himself "What is life?" and judged that physiology could tell merely "How life lives" (Hashida 1936, 296). His question "What is life?" turned his attention to the philosophy of *Dogen*. Eventually, he concluded that "to observe" was not enough to carry out genuine W-science, because objects were always separated from the observer in W-scientific observation. Deriving inspiration from the philosophy of *Wang Yang-ming*, Hashida called the genuine stance on observation *busshin-ichinyo*.

This phrase *busshin-ichinyo* refers to an intellectual circumstance. There, an observer's mind merges indistinguishably into his or her object at the ultimate stage of empathy with it (Hashida 1939, 50). The intellectual circumstance based on some inspiration accords closely with the philosophy of *Dogen*, who idealized the intellectual circumstance in grasping the world without any intervention. This intellectual circumstance is explicable in terms of two sorts of knowledge supposed in Platonism. According to Boas (1973a, 542), it is supposed that "knowledge is of two sorts: one immediate, sensory, direct grasping of that which is known, and the other mediated, 'intellectual', inferential." This intellectual circumstance, *busshin-ichinyo*, strongly emphasizes the first sort of knowledge: immediate, sensory, direct grasping of that which is known.

In the history of the Japanese philosophy, *Dogen* gave priority to the former sort of knowledge and rejected the latter.

> (*Dogen*) says "The real aspect is all things. All things are this aspect, this character, this body, this mind, this world....." When one asserts "all things are the real aspect," the predicate being of a larger denotation, the real aspect seems to contain something other than all things. But in the converse expression "the real aspect is all

things," the meaning is that there is nothing that is not exposed to us. (Nakamura 1993, 352)

As I revealed in Kawasaki (1999), the essence of the Japanese worldview is nothing that is not exposed to us. In accordance with this worldview, *kansatsu* has formulated the most suitable scheme for grasping this world. Because of nothing that is not exposed to us, it is unnecessary to infer anything hidden by means of human intelligence. Consequently, Hashida rejected the Western subject-object relation as wrong and praised the Japanese subject-object relation in return.

By insisting the Japanese subject-object relationship in the context of either the W-science or the Japanese science rather arbitrarily, Hashida competently concealed the LCI between "to observe" and *kansatsu*. In the following, I have made a translation of his opinion on *kansatsu*. In the translation, it is intended that the Japanese term *kansatsu* be uncritically replaced by "to observe" or "observation."

> With such a stance as this (*busshin-ichinyo*), observation should be carried out in the situation that an observer has deep empathy with his or her object; the observer and the object should be in perfect harmony with each other. And ultimately, they are expected intellectually to merge indistinguishably into each other. If we adopt this stance of *busshin-ichinyo* in W-science, our activity of observation will be identified exactly with the object in itself. Even though it might appear that we ourselves observe the object, only observing is carried out. Neither the observer nor the object will appear in genuine observation. When I observe an object, for example, the object is not observed by me; only observing is carried out in itself. (Hashida 1939, 29-30)

Western readers may be frustrated in trying to understand it and may feel his opinion irrational or nonsensical. Even if they feel themselves succeed in understanding something about "observation" in the foregoing, the understood solely depends on the context. Although it is generally true that words can gain their meanings from the context concerned, the understood radically differs from what Western readers have already known. The incompatibility the Western readers have just felt stems from the intentionally-overlooked incommensurability in the translation of *kansatsu* into "observation," i.e., the LCI between them.

Since the philosophy of Hashida rejects the W-scientific subject-object relationship in "observation," Western readers have an unavoidable feeling of incompatibility. The same incompatibility must be felt when Westerners encounter prohibited collocations such as "mortal God" or "irrational thought". These examples violate the accord in logos-associated relations[3]. Similarly, the meanings of "to observe" inevitably violate the accord in *kansatsu*-associated relations which are arranged activity to grasp *shizen* directly. *Shizen* is inappropriate to isolation because it is identified, for instance, with the supreme Buddha as discussed before. The Supreme Buddha must have the mystical empathy with us, the suffering people. This is why Hashida rejected the W-scientific subject-object relationship as insufficient and claimed the superiority of *kansatsu* to "observation."

[3] In a specific language, a pivotal word successively recalls a cloud of words in mind: the associated relations of this word. The associated relations of the word subconsciously guide an innate way of thinking about the word in the specific language. Since how to form such clouds solely depends on a structure of a language concerned, the innate way of thinking in the language or culture is characterized by how to form associated relations in the language (see Kawasaki 1996).

Kansatsu: the Activity

The Japanese term *kansatsu* usually appears as *gyo* in the Japanese belief system, which has been described in terms of Buddhism in the Japanese philosophy. However, this does not necessarily mean that the Japanese belief system is based on Buddhism. Because it was already Japanized or Shintonized, it is frequently useless to make a distinction between the Japanized Buddhism and Shintoism, which is the religion innate in Japan. Hashida emphasized *kansatsu* in his work *Gyo toshite no Kagaku* (Science as *gyo*, Hashida 1939), which is fully representative of his thought on *kansatsu*. The Japanese term *gyo* shows a rather wide spectrum of meanings because it springs from several Sanskrit terms[44]; the possible English equivalents are "gait", "practice" and "exercise" (Macdonell, 1924).

In the present context, *gyo* means a practice, especially a repeated exercise or activity easily performed in an exact manner without trainees' criticism or judgment. Through *gyo*, repeated exercises of this kind, trainees grasp their personality that relates closely to Buddhahood. This discipline confirms that the means and aim should merge together, and maintains its influence over education in Japan: Japanese people have believed that this outlook on endeavour can promise great educative results irrespective of resultant achievement. This is an issue that needs to be discussed in cross-cultural studies on education, but I will not go further about the Japanese hidden curriculum in this article.

Hashida emphasized these educative consequences more than the understanding of the world. His thought on *kansatsu* as *gyo* can be outlined as follows (Hashida 1939, 14-31):

> Obviously, observation plays a significant role in W-science, and symbolizes W-scientific activities. The W-scientific mode of observation, however, is insufficient to impose genuine discipline on scientists because objects are separated from scientists in observation. If scientists are separated from their objects, they cannot grasp them in the real aspect of the objects. We should replace this insufficient activity, i.e., the W-scientific mode of observation, by *kansatsu*, the authentic mode of observation.
>
> *Gyo* is simply the discipline for conducting *kansatsu*. In other words, only *kansatsu* conducted as *gyo* can regain the partition between the observer and the objects; in conducting *kansatsu*, scientists will be able to reach an ultimate stage of empathy with the objects. Furthermore, when *gyo* is achieved to a certain degree and when *kansatsu* is conducted genuinely, the one who carries out *kansatsu* and the objects in conducting *kansatsu* will melt into only *kansatsu* as *gyo*, into the activity in itself. This is the genuine subject-object relationship in W-science. (summarized and translated by the present author from the Japanese original)

The subject-object relationship Hashida insisted should not be regarded as similar to inevitable quantum-state disturbance evaluated in quantum mechanics. It is certain that an observation of a quantum necessarily disturbs its quantum states and that the relationship takes place between the observer and the quantum as an object in the quantum mechanics. However, the same observation brings the same statistical results regardless of the

[4] Bukkyo Jiten (Nakamura 1989) gives the following Sanskrit terms as the originals of the Japanese term "gyo:" gamana, carita, carya, pratpatti, bhavana, anuyoga, samskara, samskrta.

observer's personality. In this sense quanta still remain objectified; moreover, quanta cannot exert any influence upon the observer's personality. If quanta and scientists followed the subject-object relationship Hashida asserted, quanta would exert a certain influence on scientists in merging quanta and scientists into observation of quanta.

In Japanizing "observation," Hashida unwittingly presupposed that it could be equated with *kansatsu* in the first place; in other words, the first step of his procedure was to introduce *kansatsu* as an equivalent of "to observe" into the W-scientific activities or science education in Japan under the authority of Western civilization. Then, he began distinguishing *kansatsu* from "to observe." On the basis of the Japanese belief system, he attached or regained the traditional meanings of *kansatsu*, which was perfectly proper for grasping not "nature" but *shizen*. He insisted, demonstrating the superiority of *kansatsu* to "to observe," that the philosophy of *kansatsu* would prove a remarkable contribution by the East to Western civilization by a change in subject-object relationship.

This is the archetypal example of Japanizing Western concepts. In a comparison between a W-scientific conception and its Japanese counterpart, superiority of the Japanese conception to the original W-scientific one is asserted on the basis of the Japanese culture. Such ethnocentrism as this might be sound in a sense and natural response to a foreign culture. However, this assertion undoubtedly obstructs science educators' epistemological reflection on their LC setting for science education because of their disregarding difference between LC contexts concerned. I would like to insist that neither ethnocentrism nor scientism should distort science education in non-Western nation-states. A general method for avoiding both will be proposed in the final Chapter.

Anti-Essentialism Methodology

As stated above, translation ordinarily conceals LCI in W-scientific terms when science education is conducted in a non-Western language without science educators' realizing the translation. It is extremely rare for them to be aware of the LCI involved in W-scientific terms, because it is absolutely normal that very few people are conscious of their thought and action performed in their first language. It is not an exception to conduct science education in a non-Western language which pupils and science teachers speak as their first language.

Nevertheless, it is possible in principle for science educators to reveal the LCI if they conduct epistemological reflection on the respective languages. The epistemological reflection will take the shape of a comparative study between their first language, i.e., the non-Western language and a Western language that planted seeds of W-science and developed it. Because the comparative study will be conducted from the viewpoint of semantics, a branch of linguistics, linguistics is helpful in science educators' conducting the epistemological reflection. The present article is based entirely on structural linguistics, from which structuralism stemmed. For an outline of structuralism, see Caws (1973).

Structural linguistics discloses that a language inevitably entails a worldview intrinsic to the language; therefore, learning a language is assimilating the worldview inherent in the language. As learning the language, people share the same worldview with others in the LC community. Consequently, the people take the worldview for granted in the community in the same way that they naturally take it for granted that they use their first language.

Worldview

An essential feature of structural linguistics is a refusal to regard a term as a container for meanings, i.e., contents of the container. Kawasaki (1996) called it the container-contents model to regard a term as a container for meanings, and emphasized the refusal of the model. Saussure, the founder of modern linguistics, describes this refusal by coining a metaphor of a sheet of paper:

> Language can also be compared with a sheet of paper; thought is the front and the sound the back; one cannot cut the front without cutting the back at the same time; likewise in language, one can neither divide sound from thought nor thought from sound; the division could be accomplished only abstractedly, and the result would be either pure psychology or pure phonology. Linguistics then works in the borderland where the elements of sound and thought combine; their combination produces a form, not a substance. (Saussure 1966, 113)

The sentence "thought is the front and the sound the back" in the foregoing can be paraphrased in terms of the container-contents model: contents are the front and the container the back. Then, the container-contents model is refused in Kawasaki (1996)

The origin of LCI is deduced from the metaphor of a sheet paper. For instance, the terms "nature" and *shizen* have their own meanings in their respective languages. The two terms are two sheets of paper, and have their fronts and backs, respectively. As the result, those pupils who are learning W-science in the Japanese language will inevitably recollect the meanings inherent to the Japanese LC tradition in hearing the sound of *shizen*. Even though science teachers fully intend this Japanese term to convey the W-scientific meaning, Japanese pupils automatically accept *shizen* as a Japanese term that has played its own role in the Japanese system of words, the Japanese language. This is a direct result of the metaphor of a sheet of paper.

The following two citations are paraphrases of the metaphor of a sheet of paper. The first one is from *Words in Context* by Suzuki (1993, 40), a Japanese linguist:

> Man cannot come into direct contact with the elements composing his [sic] world as such. These elements constitute a world meaningless in itself, one which might aptly be described as disorderly and chaotic. One must conclude that the role of language is to bring order to this world and fashion in it meaningful and controllable objects, properties, and actions.

Before manipulating a language, one simply sees the world as meaningless. It does not consist of perceptible or considerable objects. Only after manipulating a language, one can perceive objects due to the order the language brought. Because different languages bring different types of order, sound and thought appear to be inseparable in a language. Then, the metaphor of a sheet of paper is justified.

The second one is from *Language, Thought, and Reality* by Whorf (1959, 235): "Facts are unlike to speakers whose language background provides for unlike formulation of them." This clearly concludes that various types of facts exist depending on speakers' language backgrounds. Learning a specific language, a speaker accepts a single type of facts ordered by the formulation, which the speaker's language background provides for him or her. In Whorf's usage "facts" is the counterpart of "a world meaningless in it self" in Suzuki's. Both call the citation from Saussure to mind: Linguistics then works in the borderland where the elements of sound and thought combine; their combination

produces a form, not a substance. Whorf straightforwardly states in another place: His [sic] thinking itself is in a language --- in English, in Sanskrit, in Chinese (Whorf 1959, 252). A way of thinking is functionally identical to a language.

Moreover, Whorf understood a relationship between language and recognition. The relationship is known as the principle of linguistic relativity: "all observers are not led by the same physical evidence to the same picture of the universe, unless their linguistic backgrounds are similar, or can in some way be calibrated" (Whorf 1959, 214). Obviously, what Whorf means by "the same physical evidence" is identical to what Suzuki means by "a world meaningless in it self." In "the picture of the universe" in Whorf's citation, objects, properties, and actions become meaningful and controllable as Suzuki articulates. Whorf's linguistic relativity gives a description of the origin of LC incommensurability. Owing to the difference in linguistic background, LC incommensurability arises.

Since then, linguistic relativity has been open to dispute. For example, distinguishing between strong and weak versions of linguistic relativity, Cole & scriber (1974, 59) state that their review "makes untenable any strong version of linguistic relativity." However, they also acknowledge that "few would be likely to allow linguistic relativity no role whatsoever" (Cole & Scriber, 1974, 59). They give a moderate illustration of it, a weak version: "the world is differently experienced and conceived in different language communities" (Cole & Scriber 1974, 41). Thus, people in a specific LC community share an innate worldview. The people are led to take the worldview for granted; consequently, objects belonging to the worldview appear objective.

For convenience of the following discussion, correspondence of each terminology is shown in Table 1. There, terms in the same row convey the same idea.

Table 1: Terminology

	Saussure	Suzuki	Whorf
from Abstract to Concrete	Things as Such	A World Meaningless in Itself	Physical Evidence
	Viewpoint	The Role of Language	Linguisitic Background
	Worldview		
	Actual LC Phenomena or Things		

All the three, Saussure, Suzuki and Whorf, insist that a language entails a worldview.

Table 1 also implies that a language imposes LC restrictions on people's experience. Popper, one of the greatest philosophers in the twentieth century, likens this situation to "a kind of intellectual prison:"

> Whorf himself, and his followers, have suggested that we live in a kind of intellectual prison, a prison formed by the structural rules of our language. I am prepared to accept this metaphor, though I have to add to it that it is an odd prison as we are normally unaware of being imprisoned. (Popper 1994, 52)

The reason why "we are normally unaware of being imprisoned" is that the formulation of facts is taken for granted in the LC community concerned.

In the same place, Popper also suggests how to break out of prison.

> We may become aware of it through culture clash. But then, this very awareness allows us to break out of prison. If we try hard enough, we can transcend our prison by studying the new language and by comparing it with their own. (Popper 1994, 52)

This is an actual conclusion this article will form. The final chapter will indicate that science education is the most appropriate for providing pupils with "culture clash." In order to arrive at the conclusion, however, more discussion is necessary.

At the end of this section, I introduce the concept "Standard Average European," which Whorf coined. Against the backdrop of languages shared in American first nations, he understood similarity among European languages:

> Since……there is little difference between English, French, German, or other European languages……, I have lumped these languages into one group called SAE or "Standard Average European." (Whorf 1959, 138)

The concept "SAE" concludes: all observers that share SAE languages are led by the same physical evidence to the same picture of the universe. Then, "SAE" also clarify the concept "the West." This means areas where people's first language is an SAE language. Because the W-scientific worldview is a worldview the SAE languages have already entailed, the concept "SAE" becomes critical for "learning about W-science: developing and understanding of the nature and methods of (W-)science, and appreciation of its history and development, and an awareness of the complex interactions among science, technology, society and environment" (Hodson 1998, 5). In non-Western nation-sates, where non-SAE languages are used, people do not share the history and development in W-science at all.

How to conceptualize concept

The concept "SAE" is a new object of consideration. Since Whorf's finding depends solely on the comparison his viewpoint made, Whorf neither found nor discovered the object that had existed beforehand. It was the viewpoint that created the object. Structural linguistics expresses this function of viewpoint as: a system of objects is created by a viewpoint. The expression "a system of objects" is more appropriate than another simple expression "objects," because a conceptual network is established among all objects created by a single viewpoint. Adducing examples, I will explain how a system of objects is created by a viewpoint in this section. The explanation will help science educators to realize more than two types of facts, and will naturally lead science educators to relativize the W-scientific system of objects to the other system of objects a non-Western first language has created.

The examples are cited from meteorology. The following is a typical weather chart in July (NAOJ 1989, p.300).

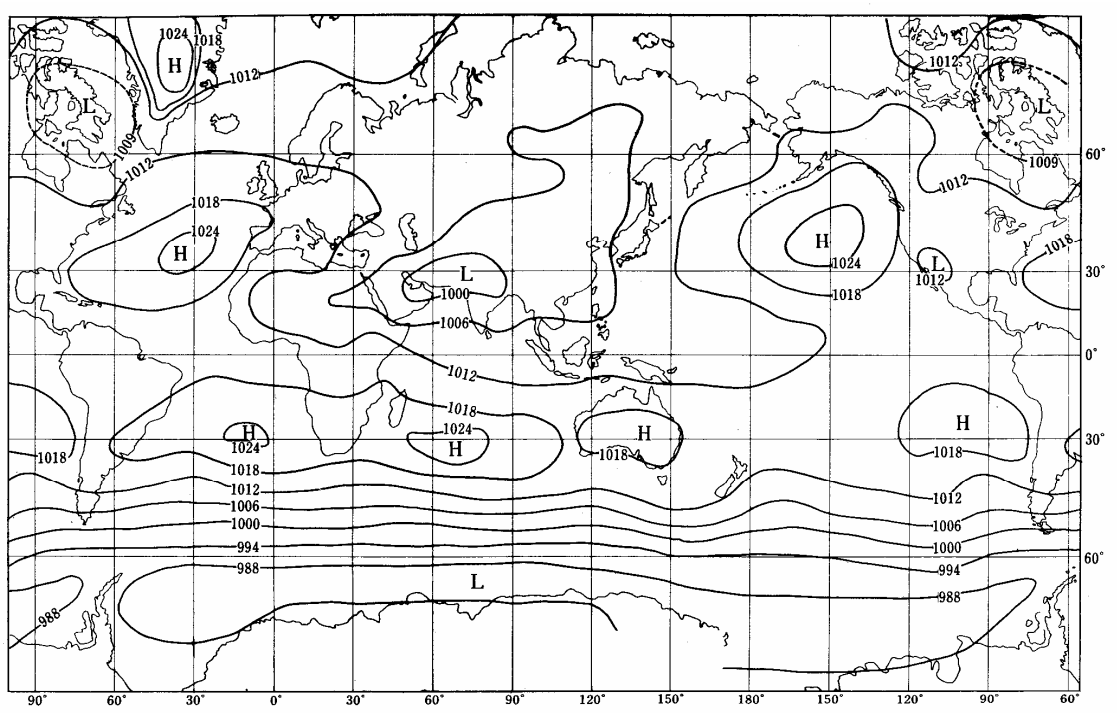

Figure 1: Weather Chart in July-Isobaric Version

Although no one can actually see all high and low pressures in the air, the reason why no one has any doubts about the high and low pressures is that the weather chart is already drawn. A weather chart is usually a map with isobaric lines at a specific date and time. In drawing the isobaric lines one gradually distinguishes all high and low pressures at the same time. This is a birth of meteorological objects of consideration.

The meteorological objects are created by the viewpoint of difference in atmospheric pressure. Before the viewpoint is established, the air "might aptly be described as disorderly and chaotic" as shown in the citation above (Suzuki 1993, 40). The viewpoint of difference in atmospheric pressure creates all high and low pressures. Because every isobaric line is drawn by the single viewpoint, the meteorological objects of consideration, i.e., all high and low pressures, form a system where they are linked to each other. A shape of a low (or high) pressure is interrelated with other high and low pressures surrounding the low (or high) pressure; there are not any crevices between the low (or high) pressure and the other low and high pressures. Each of high and low pressures cannot exist independently.

This interrelationship between the meteorological objects in the weather chart is compared to an interrelationship of linguistic signs in a specific language. A word is a counterpart of meteorological object because a language to which the word belongs corresponds to the whole space of the weather chart. Interrelating to each other, a word is given its shape of "concept" in the language as a low pressure is given its shape by low and high pressures surrounding the low pressure.

> When I utter the word *green*, such 'concept' as might be present is perhaps best represented as the combination of 'not-blue', 'not-red', 'not-yellow', etc. --- a bundle of nots. The meaning of *green* is a space in an interpersonal network of differences. To *give* the meaning is not to recover something that was present when I uttered the word but to fill up the space with other signs, to characterize some of the distinctions that define it. (Culler 1988, pp.112-113)

The bundle of "nots" of colours that surround *green* gives the shape of the "concept" of *green*. To construct the meaning space of colour is to establish the relationship between colours, in this case.

This directly concludes: the meaning space of *green* inevitably changes if the bundle of "nots" changes. For instance, imagine an LC community where people identify seven colours in rainbows: red, orange, yellow, *green*, blue, indigo and purple. And also imagine another LC community where people recognize six colours only: red, orange, yellow, *green*, blue and purple. One must conclude that these two types of *green* are not identical even if both types of *green* show exactly the same spectral range, to use the spectroscopic term in physics. The reason is that the two bundles of "nots" differ from each other. In other words, the *green* against the rest of the *six* colours differs from the other *green* against the rest of the *five* colours. Even though the two *green*s appear the same in a spectroscopic measurement, they are not commensurate with each other. LCI exists between *green*s. This stems from the fact that two LC communities differently articulate the rainbow colours from the respective viewpoints.

Moreover, it should be noticed that difference in tone of each colour is disregarded in articulating colours in rainbows. Similar disregard is performed in articulating meteorological objects of consideration. In drawing isobars, meteorologists naturally overlook micro-meteorological phenomena; for instance, small whirls are overlooked in comparison to typhoons. Conversely, being interesting in small whirls, meteorologists describe their micro-meteorological structure without considering the larger structure of the typhoon. Meteorologists have unavoidably made these implicit presuppositions. Generally, it would be impossible to articulate a concept without disregarding larger or smaller structure with respect to that of the concept. The word *green* only shows differences from other six or five colours, and disregards difference between "emerald green" and "malachite green" in the same colour of *green*. If one wants to focus on the difference between "emerald green" and "malachite green," one has to cast another viewpoint suitable for articulating the difference between "emerald green" and "malachite green."

Thus, a specific concept or object of consideration needs a viewpoint proper for articulating the concept or object. This confirms that objects of consideration are not found but created by a viewpoint which is cast on the objects at present. The following is an example for showing that another meteorological viewpoint creates a system of objects different from high and low pressures. Figure 2 is drawn from the viewpoint of difference in atmospheric temperature in July (NAOJ 1989, p.302). The different viewpoint creates warm and cold air masses in the same atmosphere.

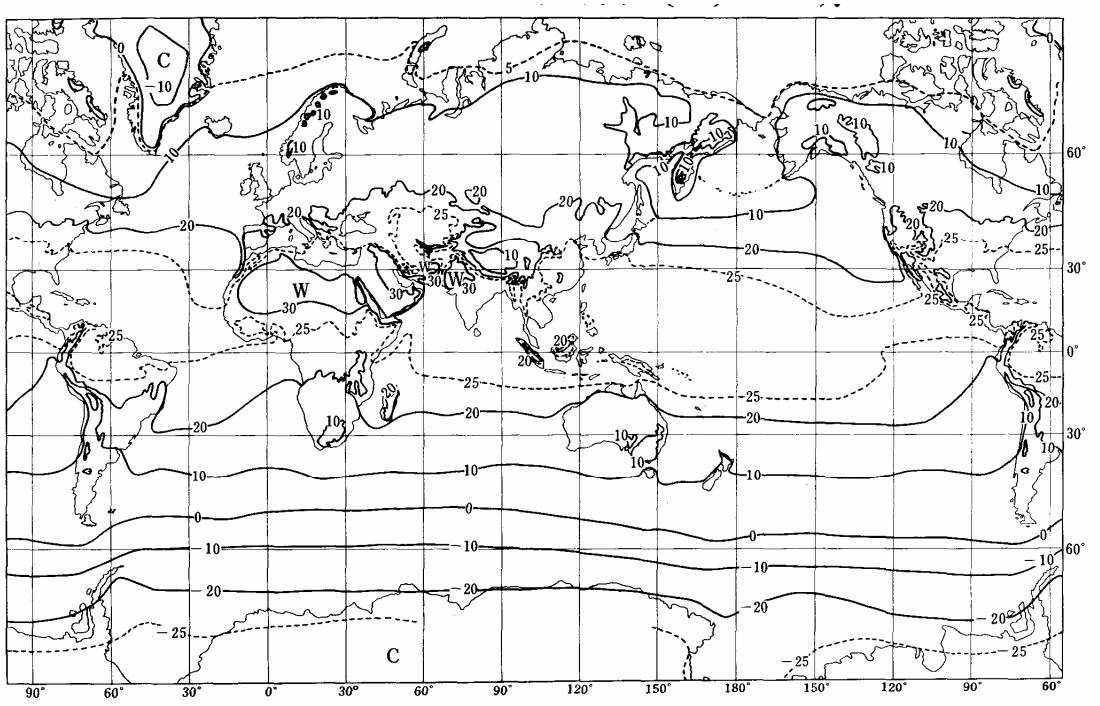

Figure 2: Weather Chart in July-Isothermal Version

In Fig. 2, all warm and cold air masses form a different system of meteorological objects from the system of low and high pressures, but show similar interrelationship between them. A shape of a warm (or cold) air mass is affected by warm and cold air masses surrounding the warm (or cold) air mass. In the same way that each high and low pressures cannot exist independently, each of warm and cold air masses cannot exist independently. Depending on viewpoint, the two systems of objects are created in the same air.

Different Viewpoint

The meteorological examples confirm that a viewpoint creates a system of objects inherent in the viewpoint. These objects had never been present before the viewpoint was cast to "the world as such." This outlook on objects of consideration is properly called "the anti-essentialist perspective." In the anti-essentialist perspective, essential nature of a thing is neither present beforehand nor found in the objective manner. The essential nature is given to the thing when it is created as an object by a viewpoint concerned. The viewpoint of the difference in atmospheric pressure creates high and low pressures in the air, and the essential nature of a high (or low) pressure is described as "a low pressure of 980 hpa," for example.

In addition to the meteorological examples, examining the process for forming constellations in the sky will how a viewpoint intervenes in making a system of constellations. Kawasaki (1996) discussed the process in terms of the birth of reality and cognition of it. It is true that the night sky is filled with stars objectively. However, without a viewpoint, the stars would have remained to be seen as randomly spread and chaotic in the sky. More precisely, no one would have seen them even as chaotic because they were not perceptible. However, once a viewpoint, namely the Greco-Roman viewpoint was cast, it articulated and divided the twinkling light points into Greco-Roman constellations; in other words, the viewpoint created the constellations as objects

to be perceived. Then, the stars became perceptible. In fact, a science teacher could neither point out a specific star, nor teach astronomy, without articulating a system of stars, either the Greco-Roman system or the system of equatorial coordinates. The system of equatorial coordinates is created by another viewpoint more abstract than the Greco-Roman viewpoint.

When the Greco-Roman viewpoint was cast, each constellation gained its own name at the same time. It should be noticed that applying a viewpoint, articulating and dividing randomly spread stars, perceiving them as constellations, and giving their names are different aspects of the same psychological phenomenon: recognition (Maruyama 1982, p.123). Supposing a different viewpoint from Greco-Roman is cast onto the night sky, a different system of constellations will be created. Minakata, a Japanese distinguished philosopher and naturalist, outlined the principle in the Chinese constellation system adhered in the Far East.

> With Polaris as the centre, the heavens are radiantly divided into the twenty-eight 'Inns' of unequal breadths, each division being denominated after its typical constellation, besides enclosing numerous 'Seats' subordinate to the latter. (Minakata 1973, p.29)

The difference between the West and the Far East will be helpful in relativizing the Greco-Roman constellation system to the Far East one.

Furthermore, the difference strongly implies a contrast in astrological recognition between Western and Far Eastern peoples. This will be easily inferred from the following instance. Even if the same star, say the star labeled as "Eta" in Ursa Major according to the Greco-Roman constellation system, is observed, "the end of the Great Bear's tail" is not commensurate with "the tip of the handle of 'Peh-Tau' or the North Ladle." "Ursa Major" recollects that the star is "the end of the Great Bear's tail" whereas "Peh-Tau" recollects that the same star is "the tip of the handle of the North Ladle." Difference in recognition between Western and Far Eastern peoples differs to the extent that a bear disagrees with a ladle.

The difference in name is identical with LCI because a system of constellation is similar to an order a language brings "to this world." Depending on name, one and the same star plays different roles in different systems of constellation. The Gestalt shift takes place when those Western people who identify that star as "the end of the Great Bear's tail" begin identifying it as "the tip of the handle of the North Ladle." In order to overcome or handle LCI, an issue that needs to be discussed is how to make the Gestalt shift happen. The necessary condition that a person can make the Gestalt shift is that the person has to know both systems of constellation beforehand. The problem to science education is that pupils are now learning W-scientific worldview and that they only know their innate worldview by which their LC community people live. This will be discussed in the final chapter.

In the context of science education in non-Western nation states, anti-essentialists' outlook on reality will play a critical role in relativizing W-science: W-scientific objects are created by the W-scientific viewpoint. Then, the next question is what the W-scientific viewpoint is, which I will discuss in the next chapter. Let us go back to how to conceptualize concepts in anti-essentialist perspective.

Synchronic and Diachronic Perspectives

Unfortunately, a wrong impression about structuralism, an archetypal anti-essentialism, has had a wide circulation: structuralism is only synchronic and then static. The following might be such an impression about structuralism.

> Now the implicit hope of anti-historical or anti-genetic structuralist theories is that structure might in the end be given a non-temporal mathematical or logical foundation. (Piaget 1973, 12)

He seemed not to be satisfied at structuralism, and became the founder of constructivism, which focuses on a diachronic or dynamic aspect of LC phenomena. However, Saussure, the founder of structural linguistics, did not state that linguistics should focus on its synchronic aspect only.

In making a rigorous distinction between the synchronic and diachronic perspectives, Saussure granted priority to the synchronic perspective: "diachronic identity depends on a series of synchronic identities" (Culler 1988, 39). The weather chart metaphor is also effective for explaining this priority. See the following two succeeding weather charts drawn from the difference in atmospheric pressure (JWA 2005).

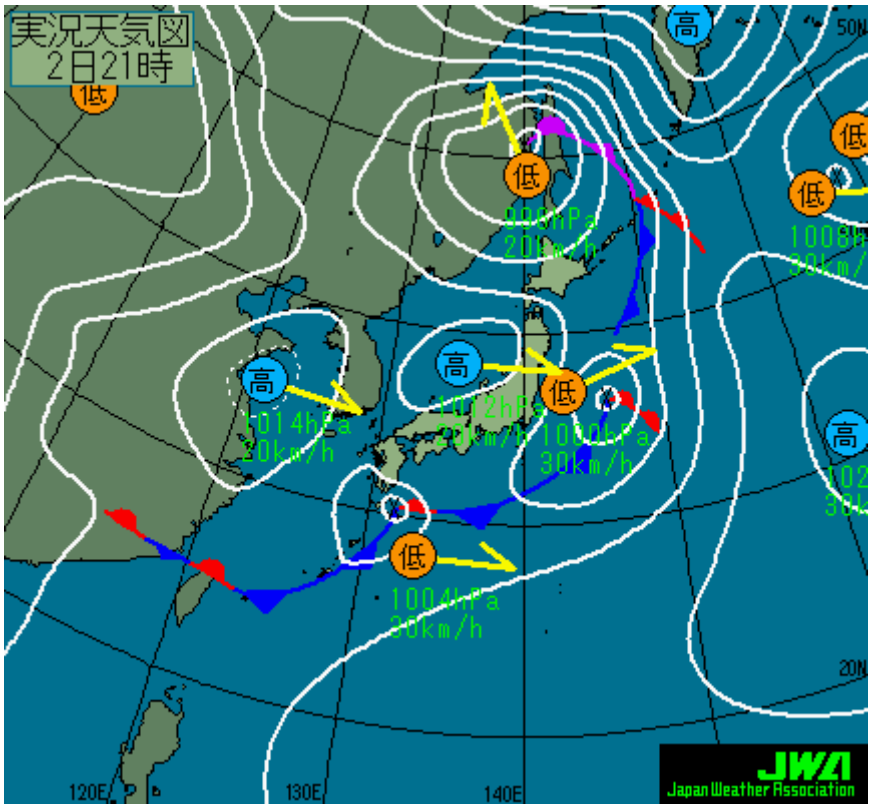

Figure 3: Weather Chart Giving the Synchronic Perspective at 21 o'clock on 2 May

A high pressure is created above the Japan Sea in the synchronic perspective at 21 o'clock on 2 May. As discussed above, this high pressure is articulated in the interrelationship among this high pressure and one high and three low pressures surrounding this high pressure. This is synchronic and then static aspect of the weather at the time.

Figure 4 is the weather chart that gives the synchronic perspective at 9 o'clock on 3 May (JWA 2005). The point that needs to be examined is the reason why the following statement is justified: the high pressure above the Japan Sea has moved to the middle of the Mainland of Japan during the last twelve hours.

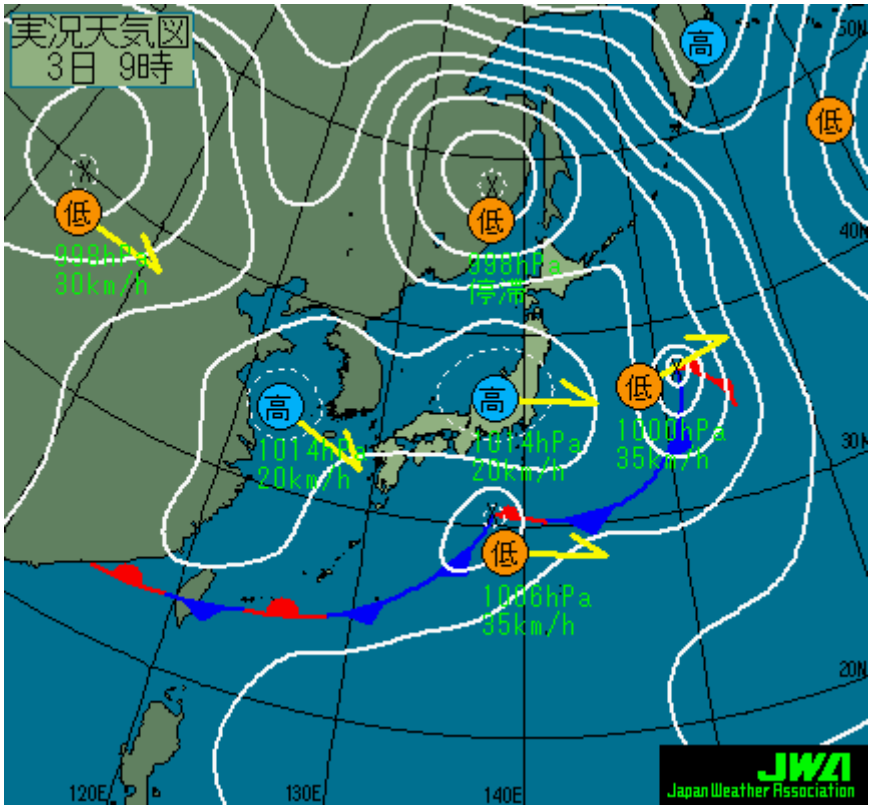

Figure 4: Weather Chart After Twelve Hours

It is definitely impossible to identify it by its meteorological values, namely, atmospheric pressure and temperature, wind force and direction, direction and velocity of motion and shape, because all of them cannot remain unchanged. The vital clue in identifying is the relationship formed in the weather chart at 21 o'clock on 2 May: the relationship among this high pressure and one high and three low pressures surrounding this high pressure. Because the same relationship is found in this weather chart after twelve hours, i.e., another weather chart drawn in the synchronic perspective, it becomes possible to identify the high pressure concerned.

To borrow Culler (1988, pp.112-113) cited before, the expression "the same relationship found in both weather charts" is paraphrased as:

> This high pressure is represented as the bundle of four nots in the weather chart at 21 o'clock on 2 May: not-"the high pressure to the north-east of Shanghai," not-"the low pressure close to the Strait of Mamiya," not-"the low pressure to the east of the Mainland of Japan" and not-"the low pressure to the south of Kushu Island." And, the same bundle of four nots is found in the weather chart after twelve hours.

The diachronic identity of this high pressure depends on the same relationship verified in the succeeding weather charts. Without the synchronic identities of this high pressure, the diachronic identity of it could not be established (Kawasaki 1997).

The following example cited from the US history will illuminate the statement "diachronic identity depends on a series of synchronic identities." As a rule, a history of a nation-state is based on the continuity of the nation-state. As is well-known, the US was founded in 1776. The reason why the US history cannot go back to the time before 1776 is that any synchronic identity could not be established by that time. Therefore, before that time, no diachronic identity could be recognized. Furthermore, it should be emphasized that, saying that the US history started from 1776, one shares the same viewpoint as the US people have. By contrast, from the viewpoint of an American first nation, a different history will be described, and the history will go back beyond the time of 1776. As I point out here, referring to the beginning of the US history, everyone shares the same series of synchronic identities as the US people have: the subjectivity shared by US people. Thus, structural linguistics insists that methodological priority should be granted to the synchronic perspective, and those who accept the synchronic perspective mean to share the same viewpoint, then subjectivity.

As is discussed above, structural linguistics never overlooks significant of the diachronic perspective. Because of the insistence of the priority of the synchronic perspective, structural linguistics is wrongly accepted as: "structuralism" is only synchronic and then static. Then, Post-structuralists discover what "structuralists" have lost sight of: "Post," in this sense, means "coming after and adding to" rather than "rejecting" (Burr 1995, 39). It should be concluded that structural linguistics method is applicable to not only static but also dynamic aspects of LC phenomena.

Four Cases of Study Based on Anti-Essentialism

In addition to the rigorous distinction between synchronic and diachronic perspectives, structural linguistics makes another distinction between *langue* and *parole*.

> Here, in the distinction between the linguistic system and its actual manifestations, we have reached the crucial opposition between *langue* and *parole*. *La langue* is the system of a language, the language as a system of forms, whereas *parole* is actual speech, the speech acts which are made possible by the language. (Culler 1988, 29)

In a person's actual speech, he or she automatically assumes that his or her hearers share the same language as a system of forms with the speaker. The system of forms determines the system of norms for using words belonging to the language they share, and is identical with the order the language brings about, to borrow the term in Suzuki (1993, 40). Therefore, *langue* as a social system of norms regulates *parole*.

As a rule, it is true that the speech acts are made possible by the language, but is also true that the speech acts are inclined to break the system of norms the language has set. Genuine creativity is born in tension between regulating the speech acts and breaking or altering the system of norms. Then, when the altered system of norms is socially accepted, a change will be made in the language. This is the general description of how a language and then culture changes. In summary, structural linguistics includes the two distinctions: the distinction between the synchronic and diachronic perspectives; the distinction between a social system of norms and a personal manifestation of it.

Hence, structural linguistics offers four frames of investigation of an LC phenomenon performed in a specific LC community depending on a combination of the two distinctions as shown in Table 2.

Table 2: Four Possible Frames of Investigation

	Sochial System of Norms	Personal Manifestation of the Systen
Synchronic Perspective	Frame 1	Frame 2
Diachronic Perspective	Frame 3	Frame 4

Within Frame 1, the LC phenomenon in the social system of norms is articulated as a bundle of nots at a certain time. Within Frame 2, the LC phenomenon as a personal manifestation of the social system of norms is articulated as the bundle of nots at the certain time. Within Frame 3, as the result of a series of investigations conducted within Frame 1, the diachronic description of the LC phenomenon is given. This is identical with a social history of the LC phenomenon. Within Frame 4, as the result of a series of investigations conducted within Frame 2, the diachronic description of the personal manifestation of the LC phenomenon is given. This is identical with a description of growing process of the person. The principal point is that all four frames of investigation are complementary to each other.

In the context of education in the general sense, a lot of educators tend to pay their attention only to Frame 4 as Piaget did. This is natural because educators take interest in each child's growing in their education. However, it is obviously insufficient for educators to pay their attention to Frame 4 only, because an investigation conducted within Frame 4 inevitably assumes the series of investigations within Frame 2 and because an investigation within Frame 2 should be conducted against the backdrop of another investigation within Frame 1. The reason why investigations within Frame 3 are less important is that the time scale of social changing is much larger than that of child changing. Therefore, a social system of norms can be regarded as static in the context of education. Table 3 gives examples of possible issues within the four frames of investigation.

Table 3: Examples of Possible Issues within The Four Frames

Frame 1	An LC Comparative Study on Education between Communiti
Frame 2	How A Child's Personality Is Built in An LC Community
Frame 3	An LC History of Education in A Community
Frame 4	How A Child's Personality Changes in An LC Community

Articulating "Language"

This chapter is devoted to coin and affirm the concept "language mode of science education." This concept will illuminate conflict specific to science education in non-Western nation-states. The conflict stems from the third condition for nation-state in Chapter 1:

> exaltation of the national language and traditions above the formerly frequent use of universal languages (in Europe Latin and later French) and universal traditions (Christianity or Islam).

As stated in Chapter 1, this condition deduces that priority should be given to "particularity" over "universality" in nation-states. In the context of science education in non-Western nation-states, "universality" corresponds to W-science, and "particularity" does to a system of knowledge which pupils are expected to acquire in their LC community compulsorily. Because teaching W-science is taken for granted in science education, science educators rarely realize the particularity-universality conflict.

The particularity-universality conflict arises when science education is conducted in the non-Western language, which is accepted as a national language in the LC community. This is particularity-oriented. There, W-scientific concepts are already translated into the national language, and W-science is taught by means of the national language incorporating the non-Western worldview different basically from the W-scientific worldview incorporated into SAE languages. Although the particularity-universality conflict stems from LCI between these two languages, science educators implicitly assume the container-contents model (see Chapter 2). As a result, they tend to disregard or underestimate LCI. However, in science education in non-Western nation-states, the means and the objective, i.e., a non-Western national language and teaching W-science, are not harmonious. In order to dissolve the particularity-universality conflict, science educators have to consider it to be a linguistic issue.

In the first place, it is necessary to discuss how a concept "language" is articulated in a system of objects of consideration, because the conception "language mode of science education" as well as the particularity-universality conflict presupposes "language." A national language, e.g., the Japanese language, is also articulated as the following bundle of "nots:" not-English, not-German, not-French, not-Korean, not-Chinese, not-Javanese, not-Hawaiian, etc. Each of them normally plays the role as genus and species in genus-species relationships, depending on viewpoint. For example, the term "Javanese" plays the role as genus in a statement "Javanese includes the three main dialects, the Central, Eastern and Western." By contrast, the same term plays the role as species in another statement "Javanese belongs to the Austronesian language family."

When "Javanese" plays the role as genus, one of these three dialects is articulated as the bundle of the other two nots. On the contrary, when "Javanese" plays the role as species, "Javanese" is articulated as the bundle of not-Indonesian, not-Balinese, not-Malay, etc. against the back drop of the genus: the Austronesian language family. The Austronesian language family can play the role of species in another viewpoint, of course. It is distinguished from other language families, for example, the Indo-European language family. It is a viewpoint that determines whether an object acts as genus or species. Once a concept, e.g., the Central dialect, Javanese or the Austronesian language family, is created as an object of consideration, the viewpoint naturally disregard nuances distinguishing among "sub-species" articulated against the backdrop of the conception of the objects (see the weather chat metaphor in Chapter 2).

Furthermore, a viewpoint plays a much more significant role. Creating a system of objects, the viewpoint attaches the real nature to an object owing to the bundle of nots within the system in the same way that a high (or low) pressure is shaped by high and low pressures surrounding the high (or low) pressure concerned. Anti-essentialism asserts that the real nature of an object cannot exist beforehand, because a viewpoint creates it. Therefore, the real nature is not found objectively, but is created subjectively. This differs radically from the W-scientific outlook on W-scientific objects.

Imagine two pairs of languages: the first pair consists of the Japanese and Okinawan languages, and the second consists of Bahasa Malaysia and Bahasa Indonesia. On one hand, although it is hardly possible for Japanese to communicate with Okinawan, the viewpoint of the Japanese subjectivity regards Okinawan in the same light as Japanese.

Because the definite rule of phonetic change makes it possible to communicate, the subjective viewpoint is not groundless. On the other hand, although it is not impossible for Bahasa Malaysia to communicate with Bahasa Indonesia, the viewpoint of Bahasa Malaysia or Indonesia subjectivity distinguishes these two languages from each other. Because these two nation-states require this distinction, the subjective viewpoint is not groundless.

The contrast between the two pairs of languages reveals arbitrariness every viewpoint involves inevitably. Whenever "language" is used, such a viewpoint is assumed. Because the concept of "something" is created by the viewpoint, it is not objective but subjective. Therefore, it is not found but created. This anti-essentialism outlook on the concept of "something" will not lead science educators to objective investigation of W-scientific objects. Science educators will turn their attention to the subjectivity that has cast the viewpoint to create the W-scientific system of objects. If science educators identify themselves with non-Western, their investigation of W-science will start with setting the W-scientific subjectivity against their LC subjectivity within Frame 1 discussed in Chapter 2.

Diachronic Descriptions

In this section I will show an example of how to set the W-scientific subjectivity against the Japanese subjectivity within Frame 1: the W-scientific worldview against the Japanese worldview. In other words, I identify myself with a non-Western person; then, I will show how I set the W-scientific worldview against the Japanese worldview I have sympathy with.

The distinction of self from others seems to be self-evident. However, the distinction becomes unclear within Frame 1 concerning social system of norms because of the universality of W-science in the context of science education in Japan, as a non-Western nation-state. Referring to the history of W-science, science educators in Japan tend to express it as the universal history of human intelligence. Of course such a viewpoint is possible because of the arbitrariness involved in any viewpoint. However, this viewpoint makes it impossible for science educators to realize, consider and resolve the particularity-universality conflict. This is the reason why I refuse the universality of W-science. I have to emphasize that I have never denied W-science.

I will develop the discussion as follows. I will place the two worldviews in the diachronic perspective based mainly on Kawasaki (2002). This means that I have already set the W-scientific worldview against the Japanese worldview following anti-essentialism. Then, depending on a series of synchronic identity, the history of one worldview is described in the relation to the other. The contrast between the two histories will remind science educators of the distinction within Frame 1. At the end of this chapter, the concept "language mode of science education" will be proposed. The concept will help science educators to set the W-scientific worldview against a non-Western worldview in Frame 1.

Thinking in the Greek Way

Burnet, who is known as the editor of the Burnet Oxford Classical Texts, asserted in the author's preface to *Early Greek Philosophy*:

> My aim has been to show that a new thing came into the world with the early Ionian teachers --- the thing we call science --- and that they first pointed the way which Europe has followed ever since, so that, as I have said elsewhere, it is an adequate description of science to say that it is "thinking about the world in the Greek way." That is why science has never existed except among peoples who have come under the influence of Greece. (Burnet, 1975, v)

The origin of science, W-science in the present context, lies in "thinking about the world in the Greek way." This is much more crucial to science education in non-Western nation-states than Western people can imagine, because non-Western people cannot relate their LC tradition to the Greco-Roman LC tradition.

To learn "thinking about the world in the Greek way" means that Japanese people who learn W-science have to alienate themselves from the Japanese culture. This is dissimilar to setting the W-scientific worldview against the Japanese worldview in Frame 1, because science educators intend to replace the Japanese innate worldview by the W-scientific worldview because of its universality. Their intension is an aspect of the particularity-universality conflict. By contrast, Western people need not alienate themselves from the Greco-Roman civilization. It is typical that Snell (1960, 227) identified the West as the linear successor to the legacy of the Greco-Roman civilization. As a result, science educators' identification in Western nation-states rarely leads them to setting the W-scientific worldview against a non-W-scientific worldview, e.g., the Japanese worldview, in the context of science education. Then, it is almost impossible for science educators who identify themselves with Western to establish Frame 1 in the context of science education. I will not go further about this in this Chapter.

Snell (1960, 228) pointed out that the essence of the W-scientific premises correlated with the maturity in the use of definite and indefinite articles in the Ancient Greek language and that the definite article in the Ancient Greek language had become "a seed for the growth of scientific concepts."

> The article is capable of making a substantive out of an adjective or a verb; and these substantivations, in the field of philosophy and science, serve as the stable objects of our thinking. But the substantives formed in this way do not refer to the same order of things as ordinary concrete nouns; ordinary material things are not the same as the objects of thought created by these substantivations. (Snell 1960, 229)

The ancient Greek language established a method of turning nouns, adjectives and verbs into corresponding abstract nouns. The definite article in the Ancient Greek language made it possible to form the abstract nouns whose referents were beyond the phenomenal, material or tangible world (i.e., in the world of Idea, to use the Platonic term).

Although today's English system of articles is greatly simplified, the definite article "the" can play the same role as Snell pointed out. In front of the singular form of a countable noun, for instance, "the" can make a general statement about all things of a particular type: "The computer allows us to deal with a lot of data very quickly in the present time." In this example, the compound "the computer" refers to "the Idea of computer," not concretely to actual computers in the phenomenal world. In the same way, when "the" is placed in front of an adjective, the compound refers its Idea corresponding to everyone or everything that can be described by the adjective: "the true, the good and the beautiful." The compound "the true" refers to something that everything true shares: the Idea of truth. SAE languages share this linguistic function.

These compounds do not refer to anything particular in the phenomenal world. Their referents are supposed to be found in the world of Idea according to the distinction between the world of Idea and the phenomenal world. In this manner, the English language has formulated the methods for conceiving abstract nouns that do not refer to anything in the phenomenal world. Then, whoever uses a noun in the English language has to decide which world its referent belongs to, though he or she does not explicitly realize the process for deciding. This linguistic decision leads English-speaking people to confirm the two opposite conceptions: "the phenomenal world" and "the world of Idea," between which Plato drew the fundamental distinction (Boas 1973b, 347).

Conversely, owing to this fundamental distinction, Western people have clarified whether an object of consideration belongs to the phenomenal world or to the world of Idea where everything is universal and eternal. The reason why W-science is believed to be universal is the belief that W-scientists strive to search the world of Idea for the W-scientific reality. Therefore, every W-scientific explanation assumes the form that W-scientific phenomena are explained in terms of abstract things or things in the world of Idea. This can be paraphrased as the following general form of explanation: Every explanation demands a system of assumptions or describes "what exists in terms of what ought to exist" (Boas 1973a, 547). In terms of the citation from Suzuki (1993, 40) in Chapter 2, "what ought to exist" is arranged by order that language has brought to this world meaningless in itself. W-science is not completed within the phenomenal world, because W-science fundamentally requires abstract nouns in order to describe what exists in the world of Idea according to the order SAE languages brought.

In contrast to this SAE linguistic function by which abstract nouns are generated, "the Japanese language does not have any fully established method of composing abstract nouns," nor has it an "established method of turning adjectives into corresponding abstract nouns" (Nakamura 1993, 533). As a matter of fact, the Japanese language has never contained articles that perform the same function as in the English language. This means that the Japanese culture has never developed the dichotomy between "the world of Idea" and "the phenomenal world" (Kawasaki 2002). To put it more precisely, the Japanese culture has never established a dichotomy similar to that developed in the Western civilization. Therefore, the Japanese LC tradition has never conceived any counterpart to "the world of Idea." I have to stress that the lack of the abstract-making function is by no means a linguistic flaw of the Japanese language. This must be understood as a characteristic of the Japanese language in a cross-cultural perspective, in Frame 1.

Instead of conceiving the world of Idea, Japanese thought has placed exclusive emphasis on the phenomenal world, as Nakamura describes:

> [W]e should notice that the Japanese are willing to accept the phenomenal world as Absolute because of their disposition to lay a greater emphasis upon intuitive sensible concrete events, rather than upon universals. This way of thinking with emphasis upon the fluid, arresting character of observed events regards the phenomenal world itself as Absolute and rejects the recognition of anything existing over the phenomenal world. (1993, 350)

This citation in the English language must sound nonsensical to those people who have acquired Western education. The reason is that the phrase "the phenomenal world itself as Absolute" does not accord with the order the English language has brought. Everything in the phenomenal world can be mutable and particular; on the contrary, the term "Absolute" clearly implies that it ought to be immutable and universal.

Thus, LCI must be realized for accurate understanding of "the phenomenal world itself as Absolute." This phrase should be understood according to the order the Japanese language has brought. As a result, there lies a difference in order between the English and the Japanese languages. The English order that arranges "what ought to exist" identifies "Absolute" as immutable and universal, but the Japanese order identifies the counterpart to "Absolute" as mutable and particular.

According to this linguistic characteristic, for instance, Ekken, a distinguished Japanese Confucianist in the early eighteenth century, "did not understand the distinction between the realms 'above form' and 'below form'," nor was he "inclined to recognize the realm which transcends and underlies the natural world of the senses" (Nakamura 1993 541-542). Although the Japanese counterpart to "Absolute" plays a similar role to that of "reality" in the Western thought, Western people must experience a feeling of incompatibility because of its fluid nature. Western people's sense of incompatibility stems from the LCI between "Absolute" and its Japanese counterpart to "Absolute."

In science education, since the Japanese order the Japanese language has brought, plainly speaking, the Japanese language, builds up pupils' background of knowledge, science educators should take notice of the difference between the English and Japanese languages. An LC difference must arise in what pupils search for in the phenomenal world between the West and Japan. In the West, abstract nouns induce pupils to search the world of Idea for something universal and immutable. By contrast, following the Japanese worldview, pupils search the phenomenal world for everything in Japan.

Ways of Thinking

The difference in language constitutes the central feature of "ways of thinking" shared in an LC community because of the order embedded in the language shared in the LC community. Nakamura (1993, 5) gives the explanation of "ways of thinking":

> The phrase "ways of thinking" refers to any individual's thinking in which the characteristic features of the thinking habits of the culture to which he belongs are revealed. "Ways of thinking" as here used will designate especially ways of thinking about concrete, empirical questions, which may, on many occasions, involve also value-judgements and question of values in ethics, religion, aesthetics, and other such human concerns. The thinker need not himself [sic] be aware of any way of thinking when he is engaged in operation of thinking…

Although the forgoing seems not to make a clear distinction between Frame 1 and 2, I situate "ways of thinking" in Frame 1, in the social context, throughout this article.

At the same time, Nakamura (1993, 5) elucidates two conceptions: "rules of logic" and "system of thought." On one hand, "rules of logic" are those explicitly expressed formal rules put forward by logicians: Typically they are the laws of identity, contradiction and the excluded middle. Since those similar "rules of logic" are found universally, they appear to be independent of LC communities. Thus, "rules of logic" do not show any difference in Frame 1.

On the other hand, he explains: a "system of thought" is a coherent, self-conscious system of thought that sprang from one or more of several ways of thinking. If "a system of thought" is interpreted as "a social system of thought," this becomes a proper object of consideration in Frame 1. In this sense, I will use "the W-scientific way of thinking" and "the Japanese way of thinking" as objects proper to considering in Frame 1. Because "the thinker need not himself be aware of any way of thinking" as pointed out in the foregoing

citation, cross-cultural investigations in Frame 1 will remind science educators of "social ways of thinking" concerned.

Since the Japanese language has never included the established method to turn abstract nouns, this linguistic feature produces a difference between the English and Japanese languages, which incorporate worldviews respectively. Therefore, a precise description of science education conducted in the Japanese language will be: Science educators in Japan teach the W-scientific content based on the world of Idea in the Japanese language that has never established the dichotomy between the phenomenal world and the world of Idea. Consequently, science educators with the W-scientific worldview might be perplexed with the Japanese way of thinking in pupils, because the Japanese way of thinking has been developed without abstract nouns. Or science educators with the Japanese worldview will be unable to realize even that they teach something different from W-scince. In the West, on the contrary, science educators find that the Western way or SAE way of thinking shares abstract nouns with the W-scientific way of thinking.

To The World Of Idea

Science educators are inclined to overlook a historical fact that characterizes the Western way of thinking. As Moor (1972) pointed out in the "Introduction" to *Movements of Thought in the Nineteenth Century* written by Mead (1972), the Western way of thinking stems from medieval theology (i.e., the Christian theology):

> The rationalism which colors European thought since 1600, and which pervades our contemporary scientific period through the assumption of the knowability of nature, of the uniformity of nature, and, consequently of the universality of natural laws, is rooted in medieval theology. Picturing the universe as carrying out the purpose of a divine, rational being, any irrational element was excluded automatically, since God not only was intelligent but had the power to make his intelligence effective. From this source come the rationalistic characteristics of modern science. Galileo, Copernicus, Kepler, and Newton, to mention only four, applied mathematics to the universe with an almost naïve trust. Mathematics, the most rational of our disciplines, would fit a rational world. (Moor 1972, xii)

Since 1600, the Christian theology has been incorporated into the W-scientific system of premises to which W-science always refers.

The reason why Christian theology could be rational is based on the combination of Christian faith and the Platonic Ideas. The combination made it possible to develop the role of things beyond the phenomenal world in the Western philosophy:

> In Saint Augustine the Platonic ideas [sic] became ideas in the mind of God, ideas in accordance with which He had created the world. In the Wisdom of Solomon (11: 20) one reads, "... Thou hast ordered all things by measure and number and weight," a verse which during the Middle Ages was understood to be the basis of all physical science. But measure and number and weight were mathematical ideas and since Neo-Platonism was highly colored with Pythagoreanism, it became almost a rule to identify the ideas on the mind of God with the mathematical ideas. (Boas 1973a, 546)

In this context, the Platonic Ideas are: "it [the world] must have been constructed on the pattern of what is apprehensible by reason and understanding and eternally unchanging;

from which again it follows that the world is a likeness of something else" (Plato 1977, 41).

As a result of the combination, the W-scientific way of thinking focuses on what happens in the world of Idea. This outlook on the W-scientific system of objects is based on the conviction that "Nature was an embodiment of the divine wisdom" (Boas 1973a, 546), the divine wisdom which conceived the Platonic Ideas. Then, scientists have devoted themselves to give descriptions of what happens in the world of Idea ever since. In addition to this, there is another dominant feature in the tradition of Western philosophy: "change is to be lamented and the Sage will reject the mutable in his search for the permanent" (Boas 1973b, 347). This opinion conforms exactly to the outlook on the W-scientific system of objects.

These features formulate what the W-scientific knowledge ought to be. W-scientific laws are believed to assume mathematical forms, because mathematics represents the immutable and universal. Since anything immutable and universal is found only beyond the phenomenal world, scientists are naturally led to describe what happens in the world of Idea in terms of abstract nouns or concepts (i.e., Ideas). Boas (1973a, 543) summarized the properties of Ideas as follows: "they are universals, class-characters, analogous to mathematical figures; they are timeless and unchanging; they are ideals, not existent objects in space-time; they are known only to the reason." These properties aptly illustrate the role of abstract nouns or concepts as the order the W-scientific language, i.e., SAE languages, has brought. Scientists are persons who conduct their thinking following this order, the W-scientific way of thinking. There, abstract nouns are absolutely necessary for describing the W-scientific knowledge: a knowledge system accessible only by reason.

Throughout the history of Western philosophy, Western people tend to discredit what is known only by sense organs. In *The Republic* (Plato 1987), for instance, Socrates says:

> The stars that decorate the sky, though we rightly regard them as the finest and most perfect of visible things, are far inferior, just because they are visible, to the true realities; that is, to the true relative velocities, in pure numbers and perfect figures, of the orbits and what they carry in them, which are perceptible to reason and thought but not visible to the eye. (277-278)

There is a clear distinction between what is known by sense organs and what is known by reason; the former is inferior to the latter. Obviously, this distinction agrees with the dichotomy between the phenomenal world and the world of Idea.

Distinguishing between what is known by sense organs and by reason, Western philosophy fostered the belief that knowledge is of two sorts: "one immediate, sensory, direct grasping of that which is known, and the other mediated, 'intellectual,' inferential" (Boas 1973a, 542). In terms of the two sorts of knowledge, Plato explains how to approach the world of Idea:

> it proceeds from consideration of species backwards to recognition of the genus, and then from general back to higher entities still, so far as reason can go, until by the agency of intuition there may come, in final stage, a sudden flash of understanding, with the recognition of the Idea of the Good itself, the final ultimate premise on which the meaning and validity of all our assumptions depend. Knowledge of this ultimate Idea will make possible a reverse process, a logical synthesis, showing how conclusions follow naturally upon one another. (Bluck 1949, 90)

Clearly, this explains how to conduct the W-scientific investigation. Thus the W-scientific methodology can go back to the age of Plato.

In the W-scientific way of thinking, what is known by sense organs must be accumulated first. This is done in the realm of experiment, and experimental data are description of what happened in the phenomenal world. However, one should not rely on them, because the knowledge of reality "exists elsewhere than in the realm of sense" (Bluck 1949, 118). Then, the W-scientific investigation demands the "inferential" type of knowledge: what is known by reason. This is the phase of abstraction of experimental data. Finally, only after sufficient logical examinations convert what is known by sense organs into what is known by reason, scientists can approach the world of Idea by the agency of intuition. In this way of thinking, they can understand W-scientific realities, and then find W-scientific laws which these realities follow in the world of Idea.

In W-scientific investigations, the first step appears to be identical to the final one in the sense that what is obtained by means of sense organs is holistic.

> The conception that ideas can be apprehended by a kind of vision or intuition, by looking and seeing them, has never been lost in Occidental philosophy, for knowing as a kind of insight, illumination, revelation, has almost always been retained. (Boas 1973a, 542)

However similar the first and the final steps are, sufficient reasoning, which is essentially analytic, at the second step is essential to arriving at the final step.

Since Plato did not lay down explicit criteria by which the thinker can judge his or her endeavour at each step to be sufficient, the relationship between these three steps has been a critical issue in the philosophy of W-science throughout the history of the Western intelligence. The criteria for taking the succeeding steps seem to be rather arbitrary. In particular, since the criterion for the final step is to be fulfilled by "a sudden flash of understanding," no one can know the goal of his or her reasoning beforehand.

For instance, Popper offers a modern paraphrase of "a sudden flash of understanding" cited from Plato.

> The advance of science is not due to the fact that more and more perceptual experiences accumulate in the course of time. Nor is it due to the fact that we are making ever better use of our senses. Out of uninterpreted sense-experiences science cannot be distilled, no matter how industriously we gather and sort them. Bold ideas, unjustified anticipations, and speculative thought, are our only means for interpreting nature: our only organon, our only instrument, for grasping her. (Popper 1980, 280)

The reason why "bold ideas, unjustified anticipations, and speculative thought" play a key role is that the role of intuition is beyond the realm of rational intelligence. Many science educators overlook this irrational and unjustified activity in the W-scientific ay of thinking; they tend to confine every W-scientific activity to the realm of rational intelligence.

The philosophy of W-science is a series of inquiries into the arbitrariness in the criteria for scientists' taking the next step. As cited above, Popper points out that "Bold ideas, unjustified anticipations, and speculative thought" are the criteria. In addition, the new philosophy of W-science insists that the first step is contingent on the second: a "theory-laden" understanding (Hanson 1958, 19). Poincare (1952, 141) made a similar inference: "science is built up of facts, as a house is built up of stones; but an accumulation of facts is no more a science than a heap of stones is a house." Since he

assumes a blueprint for the house, his words accord closely with the essence of "theory-laden" understanding. If Poincare had noticed the new philosophy of science, he would have suggested in addition to the house-metaphor: Before gathering the stones, an architect has to complete the planning for the house. Definitely, the facts obtained from experiments are already organized and codified by reason to a certain extent.

Poincare (1952, 142-143) went further: "we are not restricted to our experiment, we correct it." This is exactly the same stance as Plato adopted. It is "the agency of intuition" that makes the correction to the experimental facts. When conducting W-scientific experiments, scientists bridge the gap between these two realms according to the Western cultural tradition that Plato established. In fact, those who are familiar innately with the W-scientific way of thinking can bridge the gap without being conscious of the W-scientific way of thinking. It is natural for them to leap into the world of Idea by means of reason.

However, this leap into the world of Idea is not natural to non-Western people, and needs explaining. It is unfortunate that the leap has never been explained in the philosophy of W-science. The Western intelligence has taken the leap for granted.

> Just why value was associated with the timeless and immutable has never been explained, if indeed any explanation of it is possible. The association seems to be spontaneous and it is probable that value and duration form a couple which seems to many men to require no explanation. (Boas 1973b, 347)

In other words, this association is internalized, and remains unchanged throughout the history of Western intelligence. Therefore, anyone unfamiliar with a Western way of thinking (i.e., non-Western people who are not brought up in Western cultures) must be perplexed with this "agency," "correction" or "leap." Obviously this will be a critical issue that needs to be considered in science education in non-Western nation-states (see Chapter 4).

Owing to the internalized spontaneous association of value with the timeless and immutable, confusion occasionally arises about the correction to the experimental results even in the realm of Western intelligence. For instance, Broad & Wade (1982) express their conviction of deceit in *Betrayers of the Truth*. In the second chapter entitled "Deceit in History," they state: "The great scientists of the past were not all so honest and they did not always obtain the experimental results they reported" (22). However, all the cases they examine in the second chapter of this book, from Ptolemy to Millikan, can be qualified as proper for the W-scientific way of thinking. For example, even though Millikan might make corrections to his experimental data by "trimming" and "cooking" (Broad & Wade 1982, 29-30), his procedure is justifiable as essential in the W-scientific way of thinking according to Poincare's indication cited before: "we are not restricted to our experiment, we correct it."

In his procedure, Millikan's reason leapt from the phenomenal world to the world of Idea to reveal the W-scientific reality by means of "bold ideas, unjustified anticipations, and speculative thought" as Popper points out. Millikan must be a witness to the revelation that "the sky and the earth are married together, and the divine mysteries impressed upon the land are discovered" (Debus 1978, 120). This is not anachronistic though the quotation from Debus is about chemical philosophy in the Renaissance. Millikan seems to have shared the same attitude to reality as alchemists in the Renaissance. This is the mainstream of the W-scientific way of thinking unfamiliar to non-Western people.

Of course, the conception of knowledge does change in the history of Western philosophy. As von Glasersfeld (1995, 7) indicates, the current conception of knowledge appears dissimilar to that in the Renaissance: "The most important is that the customary conception of *truth* as the correct representation of states or events of an external world is replaced by the conception of *validity*." On one hand, it is clear that "truth" implied something related to the Creator in the Renaissance. On the other hand, "validity" still retains the similar relationship to the Creator, because only sound reasoning can justify "validity." Both terms hold "reasoning" in high regard; the two terms, "the Creator" and "reasoning," are significant members in logos-associated relations (Kawasaki, 1996).

Thus, from the viewpoint of the non-West, the W-scientific way of thinking has entailed a highly respected and sound reasoning throughout the Western history of intelligence; it is the legitimate successor to the Greco-Roman way of thinking. Insofar as the W-scientific way of thinking legitimizes mathematical forms to describe W-scientific phenomena, it associates, as the result of Western people's subconsciousness, essentially with the Biblical phrase: "Thou hast ordered all things by measure and number and weight" (*Wisd. of Sol.* 11: 20). Regardless of linguistic, cultural or religious setting for science education, science educators practically assume the shape of Christian faith in association with the world of Idea; they are subconsciously led to this assumption accepting the universality of W-science uncritically.

Into The Phenomenal World

Because the Japanese language has never formed the dichotomy between the world of Idea and the phenomenal world, nouns belonging to the Japanese language are concrete as stated above. Therefore, they can not correctly refer to W-scientific concepts which are essentially abstract, for instance, acceleration, a point mass, a rigid body, an ideal gas, etc. It is easily imagined that the characteristic feature of the Japanese language disturbs pupils to learn W-scientific concepts in the science classroom.

Owing to the lack of abstract nouns, the Japanese people are apt to consider that "what is the case" (things in the phenomenal world) is identical with "what appears to be so" (things in the world of Idea). This may lead the Japanese pupils to confuse results obtained from experiments (what is the case) with W-scientific truths (what appears to be so) described by W-scientific laws consisting of abstract nouns. This must be a fundamental issue that needs to be discussed in science education research within Frame 1. In the Japanese LC setting for science education, pupils might be led not to search for abstract concepts in the world of Idea but to inquire them into the phenomenal world.

This will be explained in the diachronic perspective on the Japanese way of thinking. The fundamental character of the Japanese way of thinking may become more comprehensible to Western people if they are aware that Japanese people essentially discredit what is expressed in words (Kawasaki 2002). This devaluing of words is identical to the devaluing of logical reasoning or of discussing reality which is known only by reason. For instance, Zen school, a school of Japanized Buddhism, assiduously cultivated this attitude against words.

> A word is a finger that points at the moon. The goal of Zen pupils is the moon itself, not the pointing finger. Zen masters, therefore, will never stop cursing words and letters. (Shigematsu 1981, 3)

Similarly, they repeatedly insisted: “Once you preach, the point is gone” (Shigematsu 1981, 83). Instead of valuing logical reasoning, Zen masters placed confidence in what was known directly by their sense organs.

The good example is already adduced in Chapter 1: Dogen’s outlook on “shizen,” which is regarded in the same light as natural things. This means that Buddhahood reveals itself in the impermanence of everything: Every natural thing is readily paraphrased as Buddhahood, which is properly called “shizen.” Nakamura concludes: “there is nothing that is not exposed to us” (1993, 352). Taking for granted that “there is nothing that is not exposed to us,” Japanese people have explained the world in terms of concrete nouns or concepts. From this point of view, both abstract concepts and the world of Idea are clumsy and unnecessary. Japanese philosophers have never rejected the mutable in their looking for the Japanese counterpart to the Creator, whose self-introduction might be “I am Shizen” as shown in Chapter 1. Thus, the Japanese term “shizen” refers even to something supernatural (Kawasaki, 1996) as also shown in Chapter 1.

In this way of thinking, Japanese people have deliberately avoided logical reasoning. They think their thoughts only within the phenomenal world. Hence, the Japanese way of thinking gives a clear contrast to the Western way of thinking by discrediting logical reasoning and confining their thoughts to the phenomenal world. These characteristics closely relate to the linguistic point that the Japanese language has never formulated the way to conceive abstract concepts.

LCI between “Experiment” and Jikken

Science education conducted in the Japanese language involves the third LCI. I have already discussed the first and second LCI in Chapter 1. They are the LCI between “nature” and *shizen* and that between “to observe” and *kansatsu*, respectively. The third LCI involved in science education in Japan is between experiment and *jikken*. Because the W-scientific way of thinking reveals itself in experiment, where W-scientific objects of consideration are observed, this LCI is identical to the LCI between “to observe nature” and *shizen no kansatsu*. In the following, I illuminate this LCI from the viewpoint of the difference in way of thinking within Frame 1.

In the sense of the W-scientific way of thinking, experiment is activities carried out in laboratories. In the Renaissance they were in the chemistry laboratories:

> the chemistry laboratory, fitted out with the most complete equipment, in which “the properties of metals, minerals and vegetables, and even the life of animals are examined, purified, increased, and united, for the use of the human race and in the interests of health.” (Debus 1978, 120)

There, alchemists or scientists devoted themselves to conducting logical reasoning “for the use of the human race and in the interests of health.” In order to advance logical reasoning, objects must be objectified as pointed in Chapter 1.

However, they did not complete their experiment until “a sudden flash of understanding” came to them at the final stage of the W-scientific way of thinking. Debus indicates successively.

> More important, however, is the fact that here “the sky and the earth are married together, and the divine mysteries impressed upon the land are discovered,” and the “divine mysteries impressed upon the land are discovered.” These are clearly

> references to the macrocosm-microcosm analogy and the doctrine of signatures. (1978, 120).

It would be impossible to refer to "the macrocosm-microcosm analogy" without Plato's "a sudden flash of understanding" or Popper's "bold ideas, unjustified anticipations, and speculative thought." At the final stage of the W-scientific way of thinking, the macrocosm-microcosm analogy might be paraphrased as: observers and objects appear to merge together. In the sense of grasping objects in a holistic manner, both Plato and Popper seem to assume a subject-object relationship similar to that Hashida assumed.

However, these two subject-object relationship must be distinguished by the respective contexts. On one hand, this subject-object relationship in the context of the W-scientific way of thinking is situated at the final stage of it. The final stage in the W-scientific way of thinking is succeeding to logical reasoning about experimental data obtained in the phenomenal world. The logical reasoning totally assures the objectivity in the W-scientific way of thinking. The problem is that Plato did not give the explicit condition for terminating the logical reasoning. Therefore, it is impossible for scientists to know when the sudden flush comes to them beforehand. This means they cannot know when they terminate the logical reasoning. To me, the history of the philosophy of W-science seems to be a history of paraphrases of "a sudden flash of understanding" raised by Plato.

On the other hand, in the context of the Japanese way of thinking, the subject-object relationship encourages Japanese people to have empathy with objects. Therefore, Japanese people strive to assure the feeling that observers and objects merge together throughout *jikken*. This Japanese term *jikken* originally means: Your *jikken* is just your experiences you actually experienced (Kawasaki 2001). Because the subject-object relationship in the Japanese way of thinking is attributed to individuals, objectivity cannot be assured in the subject-object relationship. A degree that this relationship is established depends solely on the personality of the observer. Intending to conduct a good *jikken*, an observer ought to build a good character in the first place. This requisite is set in the philosophy of *kansatsu* discussed in Chapter 1.

Although Hashida developed the philosophy of *kansatsu* more than a half century before, it survives in science education in Japan. The following is cited from *Science Education Monthly*, a journal for members of Society of Japan Science Teaching.

> If a pupil correctly follows teacher's instructions and accurately performs his or her experiment, he or she will obtain satisfactory data depending on accuracy of the experiment. The reason the pupil fails can be attributed to himself or herself. Because *shizen* as such is truth, it never betrays anyone's trust. It neither disdains nor panders to anyone. Conversely one can neither deceive nor control *shizen*. It is impossible to avoid the truth in *shizen*. (translated by the present author, Hayashi 1990)

Moreover, Hayashi (1990) insists in the same place:

> Experiment in science education has a desirable consequence: pupils can build sincere personality by performing their experiment honestly. (translated by the present author, Hayashi 1990)

Because Hayashi's opinion takes notice of pupils' personality in experiment in science education, it definitely accords with the philosophy of *kansatsu* developed by Hashida.

This is a typical example of the LCI between experiment and *jikken* in science education in Japan.

Book-Metaphor

Interestingly, both the West and Japan coined book-metaphors of nature and *shizen*, respectively (Kawasaki, Hujimura & Kawahara 1999). As is well-known, the Western book-metaphor going back to St. Augustine is found in Hermeticism.

> The religious content of early-seventeenth-century Hermeticism is evident in the world of Thomas Tymme (d. 1620), who wrote (1612) that "the Almighty Creator of the Heavens and the Earth…hath set before our eyes two most principal books: the one of nature, the other of his written Word…The wisdom of Nature book, men commonly call Natural Philosophy which serveth to allure to the contemplation of that great incomprehensible God, that were might glorify him in the greatness of his work…." (Debus 1985, 14)

Because the Creator is incomprehensible, contemplating Him is only what human beings can do. It must be interesting to remember that the English term "contemplation" is considered to be the most possible English equivalent of *kansatsu* as shown in Chapter 1. The book of nature led philosophers to "allure to the contemplation of that great incomprehensible God."

Even in the present time the doctrine remains alive in the W-scientific way of thinking that the Creator "hast ordered all things by measure and number and weight" according to *Wisd. of Sol*. (11: 20). This is the reason why mathematics is a principal tool for investigating natural phenomena. Mathematics, i.e., logical reasoning, is essential for reading the book of nature. After reading the book of nature, i.e., logical reasoning, a sudden flash of understanding might come to scientists. This is comparable with Hermetists' contemplation of the great incomprehensible God.

By contrast, the Japanese version of book-metaphor is found in *Yui Itsu Shinto Myo Ho Yo Shu* written by Urabe (1435-1511), who advocated Shintoist Monism. He asserted the truth of Shintoism by using the book-metaphor:

> The Heaven and the Earth is the Book on the basis of which Shinto is established. The sun and the moon confirm that the Book proves is true. (translated by the present author, Osumi 1977, 249)

As shown in Chapter 1, "there is nothing that is not exposed to us." This means that Shinto has never has such a conception that needs logical reasoning. The Book is enough to be just read, because the sun and the moon as parts of *shizen* are the evidence. In return, Japanese have cultivated the stance on *shizen*: having empathy with it.

The similar outlook on *shizen* is found in *Rika*, the school subject of science in Japan. Examining the pupils' activity *jikken* in the science classroom of the fourth grade of primary school, Nakayama and Iwakiri (1999) suggest that pupils try to give a full description of diversity of a W-scientific phenomenon they are really faced with. They tend not to confirm their conclusion asserting ideals or universals by logical reasoning following the W-scientific way of thinking. Pupils in *Rika* are inclined to stop logical reasoning after *jikken* though logical reasoning is essential after experiment in the W-scientific way of thinking. The more information pupils obtain from *jikken*, not from experiment in the sense of the W-scientific way of thinking, the deeper understanding of

shizen they can made. The reason is that "there is nothing that is not exposed to us." This must stem from the LCI involved in *shizen*, *kansatsu* and *jikken*.

Language Mode of Science Education

The LCI involved in the three typical key terms, *shizen*, *kansatsu* and *jikken*, have misled pupils as well as science educators since Japan situated *Rika* in the national education system in the last period of nineteenth century. In order to resolve the LCI, science educators have to realize that a worldview is entailed in the language used in science education. Popper gives his assent to the metaphor: a prison of language.

> Whorf himself, and some of his followers, have suggested that we live in a kind of intellectual prison, a prison formed by the structural rules of our language. I am prepared to accept this metaphor, though I have to add to it that it is an odd prison as we are normally unaware of being imprisoned. We may become aware of it through culture clash. But then, this very awareness allows us to break out of the prison. If we try hard enough, we can transcend our prison by studying the new language and by comparing it with our own. (Popper 1994, 52)

Popper gives everything that needs for science educators' resolving the LCI in the foregoing. Science educators are unaware of the LCI in science education conducted by the Japanese language. Being aware of the LCI between the English and the Japanese languages, they will liberate themselves from the LCI, an operation of the prison of language on non-Western nation-states people. In order to be aware of the LCI, science educators have to undergo "culture clash." It is Frame 1 that prepares them to undergo it by means of comparative studies on LC setting for science education. In other words, Frame 1 makes it possible for science educators to realize LCI, and then to resolve it.

The notion "language mode of science education" will help science educators to undergo the culture clash in the synchronic perspective: within Frame 1. For instance, the Japanese language mode of science education is the science education conducted in the Japanese language. Considering it as the Japanese language mode of science education, science educators will become able to distinguish it from other language modes of science education, namely, the English language mode of science education, the Bahasa Malaysia mode of language education, the Chinese language mode of science education, etc. Those science educators can compare between language modes of science education.

This notion readily leads science educators to a strategy for conducting science education in non-Western nation-states: science education should be associated with foreign language education (Kawasaki 1996; 2002). This does not mean that science education should be taught through the English language, but expects science educators to take consideration of the fact that W-science is described in a language incommensurate with the Japanese language, a typical non-SAE language. In foreign language education, the transcending condition Popper set is naturally fulfilled. There, educators are always aware that they are now teaching a foreign language, and distinguish it from the language pupils use in their daily-life. Educators' awareness reminds pupils that they have to distinguish their language from the foreign language they are learning. Then, the problem of LCI is resolved in principle. Rather, an aim of foreign language education is attracting pupils' attention to LCI. Realizing LCI, pupils will be able to avoid conceptual confusion and will liberate themselves from the prison of their own language.

I would like to emphasize that this scheme of science education can satisfy the two conditions for nation-states shown in Chapter 1: they are introduction of modern science and technology in the service of the nation (as the second condition), and exaltation of the national language and traditions above the formerly frequent use of universal languages (as the third condition). Science educators are inclined to believe these two conditions to disagree with each other in non-Western nation-states. However, the awareness of LCI can reconcile these two conditions. And the awareness will be brought by the strategy: Science education should be associated with foreign language education.

Towards Worldview Education beyond Language-Culture Incommensurability[1]

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Abstract: This article presents an axiomatic expression of science education: [SCIENCE EDUCATION] is a system of teaching [SCIENCE]. The axiom includes two indefinable terms, [SCIENCE EDUCATION] and [SCIENCE]. In the same way that axiomatics of geometry distinguishes among axioms, postulates and theorems, the axiom presupposes a distinction among the three stages of cognition: axiom, postulate and theorem. This distinction, which is properly called the axiomatics model, will draw science educators' attention to how scientific concepts are distorted, and will develop science education towards worldview education. In the context of science education, worldview education has the potential to enable science educators and pupils to liberate themselves from their language-culture prejudices. On the basis of the axiomatics model, mutual understanding of different language-culture communities will be greatly promoted in the science classroom.

Keywords: Language, Worldview, Incommensurability, Axiomatics and Structuralism.

Introduction

Recently, I coined the notion of "language mode of science education" for the purpose of examining critically the nature of science education portrayed in non-Standard Average European (SAE[2]) language milieus (Kawasaki, 2002). In Japan, concepts of Western modern science are translated into Japanese words. A typical example is the English word "nature" being equated with the Japanese word "shizen." However, this Japanese word normally refers to the supernatural as well as to natural things (Kawasaki, 1996; 2002). As a result, "shizen" may suggest the supernatural to pupils in the context of science lessons. In this way the Japanese language mode of science education leads pupils to misunderstand not only Western scientific concepts but also Western science. However, this problem is rarely realized amongst Japanese science educators who uncritically accept such translations. It is essential, therefore, to differentiate between "the Japanese language mode of science education" and genuine science education in which Western

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[2] In this article, I distinguish "non-Western" from "Western" by adopting a linguistic criterion, which Whorf (1959, 214) proposed as "Standard Average European" abbreviated to "SAE." The notion "SAE" stands for English, German, French, etc., between which differences are insignificant against differences in Asian, African, Polynesian, etc. languages (for details, see Whorf 1959, 214). This makes it possible to articulate the Western culture and to compare it with the Japanese culture (see Kawasaki 1996). The present article refers to English as a representative of SAE.

scientific concepts are taught correctly. By failing to do this, Japanese pupils are likely to fail to achieve a critical scientific literacy in which they are "learning science," "learning about science" and "doing science" (Hodson, 1998).

An important question arises in relation to the Japanese language mode of science education: how to draw Japanese science educators' attention to pupils' conceptual confusion originating from the Japanese translation. The notion of "language mode of science education" provides a powerful means for enabling science educators to differentiate their own language mode of science education from other language modes of science education; in other words, this notion offers a *differentiating viewpoint*. Depending on the non-SAE language used in science education, a differentiating viewpoint will remind science educators of potential conceptual confusion caused by translation.

Building on this earlier approach, with the help of axiomatics, this article presents a viewpoint for integrating various language modes of science education. An *integrating viewpoint* enables science educators to realize and reject the (implicit) claims to universality of Western modern science. Likewise, other language modes of science education will lose their rationales for claiming universality. Instead, all language modes of science education will acquire a new rationale - *worldview education* - which encourages pupils to foster their own language-culture identity whilst acquiring correct concepts of Western modern science.

Hereafter, the term "Western modern science" is abbreviated to "W-science" in the same way as Kawasaki (1996). There, "Western modern science" was termed "Western ethno-science," and then abbreviated as "W-science." Hence, the abbreviation indicates the relativistic view of W-science. In addition, the modifier "language-culture" is abbreviated to "L-C." In the next section, "L-C incommensurability" is discussed briefly on the basis of my recent articles. Axiomatics is outlined in the third section, and a system of axioms about science education conducted in various L-C settings is proposed in the fourth section. The fifth section shows that the system of axioms encourages science educators as well as pupils to have a subjectivity-consciousness mind. The final section indicates that the subjectivity-consciousness mind will develop worldview education from science education conducted in various languages and that the subjectivity-consciousness mind will liberate pupils from "a prison of language."

A Worldview Incommensurate With Another

This section illustrates L-C incommensurability, and will be helpful to the present discussion. The container-contents model of language views words as a container for their associated concepts. This model justifies removing the shizen-concept from "shizen" as the container and pouring the nature-concept into it (Kawasaki, 1996). In uttering "shizen," science educators expect this Japanese word to convey correctly the nature-concept. This is what science educators automatically assume in the Japanese mode of science education. However, from a structural linguistics perspective, a word cannot be a container for its concepts, and so this model should be rejected (Kawasaki, 1996).

In a specific language (i.e., a system of words), a word cannot acquire its concept without having a relation to other words in the system. If the container-contents model were correct then a word could acquire its concept in a self-determining manner. Culler (1988) explains this by adducing the example of how the word "brown" acquires its concept within a system of colours.

> Brown is what is not red, black, grey, yellow, etc., and the same holds for each of the other signifieds; When I utter the word green, such 'concept' as might be present is perhaps best represented as the combination of 'not-blue', 'not-red', 'not-yellow', etc. --- a bundle of nots. The meaning of green is a space in an interpersonal network of differences. To give the meaning is not to recover something that was present..... (p.26; pp.112-113)

The green-concept is determined by a bundle of nots shared in a specific L-C community. It is important to compare two types of "green" in two different L-C communities. One L-C community articulates the rainbow in terms of seven colours whereas the other articulates it in terms of six colours. Even though the two greens are exactly the same in the sense of spectroscopy, they are not interchangeable for the reason that the two bundles of nots differ from each other.

In the same way, a word in a language is rarely directly interchangeable with a foreign word equated to it through translation because words acquire their concepts in bundles of nots. In acquiring its specific concepts every word refers eventually to all other words in the same language. Therefore, it does not make good sense to consider L-C phenomena without also considering the interrelationship among words. The notion of interrelationship is identical with "order" in the following citation from Suzuki, a distinguished Japanese linguist.

> Man cannot come into direct contact with the elements composing his [sic] world as such. These elements constitute a world meaningless in itself, one which might aptly be described as disorderly and chaotic. One must conclude that the role of language is to bring order to this world and fashion in it meaningful and controllable objects, properties, and actions. (1993, p.40)

The order a specific language brings to this world does not allow each word to acquire its concepts in a self-determining manner. Those people who speak a language as their first language are usually unaware that the order establishes a set of norms by which they can communicate. The set of norms is social and is properly called a *worldview*.

Being established as a way "to bring order to this world and fashion in it meaningful and controllable objects, properties, and actions," worldview is woven into the language. At the same time, a value system, by which people live in their L-C community, comes into existence. This is the reason why "Facts are unalike to speakers whose language background provides for unlike formulations of them" (Whorf 1959, p.235). In sharing the same language, people share an identical worldview. L-C incommensurability is experienced by persons who live by different worldviews.

It will be helpful in understanding L-C incommensurability to imagine two L-C communities: the Duck community and the Rabbit community. In the Duck community people have never known rabbits, and in the Rabbit community people have never known ducks.

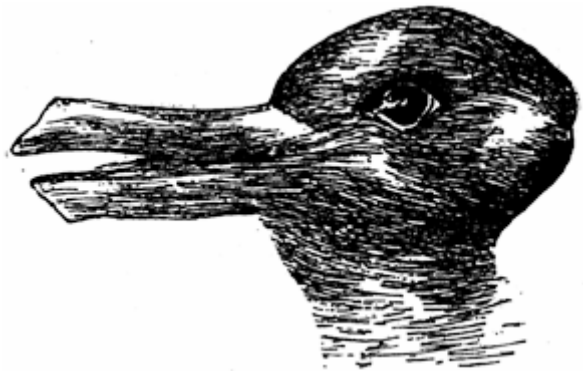

Fig. 1: Duck/Rabbit Figure (Shifting Figure) from Jastrow (1900, p.295)

When a Duck person and a Rabbit person see Figure 1 at the same time, the Duck person's cognition is incommensurate with the Rabbit person's. The Duck person will regard it as a duck whereas the Rabbit person will regard it as a rabbit. The Duck person must see the protruding things as beaks, but the Rabbit person must see the same protruding things as ears. Because beaks and ears play different roles in their respective cognition, the Duck person cannot be in agreement with the Rabbit person. This is an example of L-C incommensurability between the two L-C communities.

As is well known, Jastrow (1900, p.295) invented this figure, a shifting figure, in the context of gestalt psychology. Shifting figures "were originally used by gestalt psychologists in their attack on the constancy hypothesis, i.e., the claim that what we see is entirely determined by the retinal image" (Brown, 1979, pp.84-85). Obviously, gestalt psychologists presuppose that a single person experiences a gestalt shift, for which the necessary condition is that the person must know both ducks and rabbits beforehand. Thus, the two types of cognition -- duck and rabbit -- suddenly shift repeatedly from one to the other. I will not go further into gestalt psychology; rather, I will focus on the necessary condition.

Given the necessary condition for this gestalt shift, the duck and rabbit persons cannot experience such a gestalt shift. More importantly, the Duck people do not realize that they cannot imagine rabbits, nor do the Rabbit people realize that they cannot imagine ducks. Thus, L-C incommensurability originates from ignorance of this type: lack of knowledge about both what is known and *what is unknown*. Overcoming this lack of knowledge requires awareness of the theory of knowing (i.e., epistemology), in which science educators frame both knowledge and ignorance. From a critical constructivist perspective, Taylor (1998, p.1112) advocates science educators engaging pupils in epistemological reflection on the "social context" of their learning, because the knowledge and ignorance are societal. This is an assignment for those science educators who conduct non-SAE language modes of science education.

To clarify their task, imagine that the Duck and Rabbit communities correspond to SAE and non-SAE L-C communities, respectively. The Rabbit person can be likened to science educators whose first language is a non-SAE language. In the non-SAE language mode of science education, they teach W-science to pupils whose first language is the same non-SAE language. These pupils' worldview differs from the W-scientific worldview woven into SAE languages to the same extent that the worldview shared in the Rabbit L-C community differs from that of the Duck L-C community. Although pupils unwittingly systematize their experience of natural phenomena in accordance with their worldview, very few science educators realize this difference in pupils' cognition, especially science educators who uncritically accept the container-contents model.

Moreover, science educators are likely to articulate their experience of natural phenomena in accordance with their own worldview.

Focusing on this difference in pupils' experience in the context of a social constructivist perspective on science teaching, Cobern (2000, p.6) explains the functional aspect of worldview: "a person's thinking is based on a set of first principles." He also defines: "worldview is the foundation upon which a person constructs cognitive and perceptual frameworks" (Cobern, 2000, p.9). Thus, a constructivist perspective on science teaching accepts a variety of worldviews as a set of first principles. However, in the end the constructivist perspective seems to emphasize only the W-scientific worldview for pupils' genuine understanding of W-science. Although the emphasis assures pupils' genuine understanding of W-science, they will be in danger of an L-C identity crisis in exchange for genuine understanding. This emphasis causes their conceptual confusion about the shizen-experience (or not nature-experience), in the Japanese language mode of science education.

I have discussed pupils' conceptual confusion caused by science teachers' unawareness in the Japanese language mode of science education. From the viewpoint of structural linguistics, this conceptual confusion can be illustrated in three ways. First, as discussed already, the Japanese term "shizen" refers to the supernatural (Kawasaki, 1996). Second, the Japanese word "kansatsu", which is believed to be an equivalent of "to observe", encourages pupils to have mystical empathy with their objects in the science classroom; the closest possible English equivalent of "kansatsu" is "to contemplate" (Kawasaki, 1999; 2002).

And third, the Japanese word "jikken", which is believed to be an equivalent of "experiment," does not inspire pupils to form *genuine* W-scientific laws due to an inherent lack of a dichotomy between the phenomenal world and the world of Ideas, to use the Platonic term (Kawasaki, 2001; 2002). Because this dichotomy is a characteristic inherent in SAE language and because the L-C incommensurability concerned with the three examples is closely related to the lack of the dichotomy in the Japanese language, it is highly probable that other non-SAE L-C settings for science education put pupils in similar states of conceptual confusion. Therefore, the present discussion is applicable to other non-SAE language modes of science education.

Integrating Viewpoint

In conducting epistemological reflection on a non-SAE language mode of science education, science educators have to realize an encounter with an SAE language mode of science education similar to the Rabbit person being confronted with the Duck culture. This leads science educators to establish a viewpoint *differentiating* between the non-SAE and the SAE language modes of science education. Therefore, the notion of "language mode of science education" is an archetypal example of the differentiating viewpoint. However, the differentiating viewpoint alone is insufficient for epistemological reflection. An integrating viewpoint is imperative. Without an integrating viewpoint, science educators would be inclined to judge one of the language modes of science education as supreme: most likely the SAE language mode of science education. These science educators unintentionally support scientism, that is, a belief in the superiority of W-science based on its (presumed) universality.

In order to avoid this judgement about W-science, it is necessary to establish an *integrating viewpoint* which assures equitable treatment of all language modes of science education. The integrating viewpoint serves as a complement to the differentiating

viewpoint. The relationship between these two viewpoints is similar to a genus-species relationship. The integrating viewpoint articulates a genus, whereas the differentiating viewpoint articulates different species belonging to the same genus. For instance, regarding the Duck/Rabbit shifting figure, the integrating viewpoint articulates the figure that is not yet interpreted as a duck or rabbit. The differentiating viewpoint finds the difference between the Duck and Rabbit types of cognition.

It is the integrating viewpoint that makes it possible to realize and discuss the difference, but the significance of an integrating viewpoint is usually overlooked. Against the backdrop of the integrating viewpoint, science educators will be able to investigate features of various language modes of science education in the same way that biologists investigate various species within a single genus. It is the integrating viewpoint that makes it possible to investigate various language modes of science education. Therefore, both the differentiating and integrating viewpoints should be equally illuminated.

Thus, it is essential to establish the integrating viewpoint in comparative studies in science education. However, comparative studies infrequently describe their integrating viewpoints. Comparative studies should give explicit descriptions of why science education in an L-C setting is comparable with that in another L-C setting. Since a possible integrating viewpoint is implicitly assumed, science educators are inclined to judge the L-C difference in science education only from SAE language modes of science education. This outlook on science education research is far removed from epistemological reflection and from achieving equity amongst various language modes of science education.

An integrating viewpoint will remind science educators about their outlook on science education research, and will help them to be aware of the backdrop against which comparative studies on language modes of science education is conducted. The backdrop of the integrating viewpoint offers a commonality for all language modes of science education, enabling science educators to describe L-C incommensurability. Thus, the integrating viewpoint also works as a framework within which all language modes of science education are articulated.

The essence of the integrating viewpoint is based on axiomatics, which gives a general description of geometry. As is well known, the axiomatic system of geometry makes it possible for mathematicians to think of various types of geometry -- Euclidean and non-Euclidean geometries -- “in the one” (Blanche, 1973, p.168). “The one” appears to be an axiomatic system, and is properly called “metageometry” that is a typical example of the integrating viewpoint. All types of geometry are constructed within this single axiomatic system. Thus, a genus-species relationship exists between “metageometry” and all types of geometry.

All types of geometry are actually constructed from combinations of the single axiomatic system and respective postulates. The following is a part of the axiom system of geometry.

> If a point *P* belongs to a line *L*, then we may say that *P lies on L* or that *L passes through P*. Similarly, if *P* belongs to a plane *E*, then we may say that *P lies in E* or that *E passes through P*. (Moise, 1974, p.37)

It should be noticed that the terms “line,” “point” and “plane” are indefinable; mathematicians are prohibited from finding any meaning in these indefinable terms. This is identical to the point that the intension of indefinable terms is nil and that their extension is unlimited. This is the essence of “integrating” in the context of the present discussion.

Instead, mathematicians focus their attention on the relationships among the indefinable terms appearing in the axioms.

> [O]nly the relations are determined exactly and universally by the axioms, but nothing prevents the same system of *relations* from being able to support different systems of specific *interpretations*. (Blanche, 1973, p.168)

Since their extension is unlimited, it is possible to make various interpretations within a single axiomatic system. Accepting different interpretations of the same system of axioms, mathematicians construct different geometries. Mathematicians' opinions of indefinable terms accords exactly with that of structural linguists: a concept of a word appears itself in a bundle of nots. The bundle of nots does nothing but establish the interrelationship among words in the language.

Mathematicians make different interpretations of the single axiomatic system by combining it with different postulates. In a combination of the single axiom system and a postulate, indefinable terms acquire their meanings intrinsic in a specific geometry. Three typical postulates of "parallel" are shown in the following. They create the three geometries, the Euclidean, Lobachevskian and Reimannian, respectively.

> *The Euclidean Parallel Postulate*: Given a line *L* and a point *P* not on *L*, there is one and only one line *L'* which contains *P* and is parallel to *L*.
> *The Lobachevskian Parallel Postulate*: Given a line *L* and a point *P* not on *L*, there are at least two lines *L'*, *L''* which contain *P* and are parallel to *L*.
> *The Riemannian Parallel Postulate*: No two lines in the same plane are ever parallel.
>
> (Moise, 1974, pp.114-115)

In the present discussion, it is not necessary for those who are unfamiliar with geometry to understand what the foregoing means. The point critical to the present discussion is that the three postulates are definitely contradictory to each other (the underlined). Owing to this contradiction, corresponding theorems derived in different geometries are inevitably contradictory. For instance, "the sum of the angles of a triangle is equal to two right angles in Euclid's geometry, less than two right angles in that of Lobachevsky, and greater than two right angles in that of Riemann" (Poincare, 1952, p.39). Even though the three types of triangle are incommensurate with each other, the reason they are comparable is that all geometries share the same axiom system as the integrating viewpoint.

It is meaningful to distinguish between two types of contradiction. One is about postulates and the other about theorems. The contradiction among theorems is derived from that among postulates. In the following, the contradiction among the theorems will be likened to L-C incommensurability, and the contradiction among the postulates will be likened to differences in worldview between L-C communities. In this way of distinguishing between the two types of contradiction, difference between language modes of science education will be derived from differences in worldview as "a set of first principles" (Cobern, 2000, p.6).

Consequently, if a proper axiomatic system is established, various language modes of science education will become comparable with each other on the basis of the overriding axiomatic system as the integrating viewpoint. Taking the integrating viewpoint into account, science educators will be able to ensure equity of language modes of science education in the same way that mathematicians ensure complete equity of all

types of geometry. Obviously mathematicians think it ridiculous to give a specific geometry (e.g., Euclidian geometry) priority over others.

Axiomatics Model of Science Education

In the following, I propose a system of axioms regarding science education or all language modes of science education. This axiomatic system functions as the axiomatics model for investigating language modes of science education from the L-C equitable point of view. By means of the axiomatics model, it becomes possible to distinguish among the three stages of cognition - the axiom, postulate and theorem stages of cognition - in the same way that the general geometry distinguishes among geometrical axioms, postulates and theorems.

Axiom (1) is a possible axiom about "the world" in the sense of Suzuki (1993, p.40). The axiom includes indefinable terms [SCIENCE], [KNOWLEDGE] and [NATURE] at the axiom stage of cognition. To emphasize indefinable terms, I have expressed them in capital letters, and have put them in brackets.

[SCIENCE] is a system of [KNOWLEDGE] about [NATURE]. (1)

This establishes only the relationship among [SCIENCE], [KNOWLEDGE] and [NATURE], and describes nothing about actual L-C phenomena experienced in an L-C community.

When a language brings order to "his world as such" (Suzuki, 1993, p.40), a system of objects is articulated or created in the L-C community (Kawasaki, 1996). A worldview as a set of first principles begins working. In this way, and only when Axiom (1) is combined with a worldview at the postulate stage of cognition, the composite arranges for the L-C people to produce or articulate L-C phenomena inherent only in their L-C community. This is the birth of reality inherent in the L-C community. Thus, Axiom (1) will reveal the process of the birth of reality to science educators, and then will lead science educators to consider the L-C phenomena at the theorem stage of cognition. Accepting the process of the birth of reality, science educators will realize the three stages of cognition, that is, the axiom, postulate and theorem.

In addition to Axiom (1), "language mode of science education" is axiomatized. This offers an integrating viewpoint against which it becomes possible to compare various language modes of science education.

[SCIENCE EDUCATION] is a system of teaching [SCIENCE]. (2)

Axiom (2) includes a new indefinable term [SCIENCE EDUCATION] that has the extension of all language modes of science education, and forms an axiomatic system with Axiom (1) by sharing the same indefinable term [SCIENCE] with Axiom (1). Being combined with a specific postulate, the axiomatic system produces a language mode of science education and a science at the theorem stage of cognition.

This axiomatic system will stimulate science educators to conduct epistemological reflection on their language modes of science education if science educators take account of the process of the birth of reality. Then, their epistemological reflection will make it possible to conduct cross-cultural investigation of language modes of science education from an impartial point of view.

For example, in the Japanese language mode of science education, science educators will take the Japanese worldview into consideration realizing that the Japanese worldview is already woven into the Japanese language. In this perspective, a possible statement obtained from the axiomatic system is: *The Japanese language mode of science education is a system of teaching W-science*. This sentence at the theorem stage reveals what is usually done in the Japanese language mode of science education, and illustrates that the two different postulates are involved in it. One is the Japanese worldview postulated in the Japanese language mode of science education, and the other is the W-scientific worldview in order to articulate W-science at the theorem stage.

Confusion will be brought at the theorem stage, because these two worldviews are definitely inconsistent (Kawasaki, 2002). Science teachers in the Japanese language mode of science education are comparable to those mathematicians who could not distinguish Euclidean and non-Euclidean parallel postulates in geometry. The fictitious mathematicians would arbitrarily derive theorems from the two postulates. Due to the inconsistency between the two postulates, some theorems would be contradictory to others. However, the mathematicians could not identify the contradiction because of their confusing the two postulates. For the similar reason, science teachers tend to overlook contradictions at the theorem stage. This is the principal reason for conceptual confusion in pupils' minds in the Japanese language mode of science education. In order to prevent this confusion about worldviews as a postulate, science teachers need to differentiate carefully between the W-scientific and the Japanese worldviews, and elucidate the difference between them.

At the end of this section, I tabulate the six indefinable terms, namely, [LINE], [DUCK/RABBIT FIGURE], [LANGUAGE], [WORLD], [SCIENCE] and [SCIENCE EDUCATION]. Table 1 shows how each term acquires its actual meaning at the theorem stage of cognition. In the process of acquiring meanings, the relationship that the axiom establishes remains unchanged.

Table 1: Indefinable term, Postulate and Reality at the Theorem Stage of Cognition

INDEFINABLE TERM	POSTULATE	REALITY AT THEOREM STAGE
[LINE]	Euclidian parallel postulate	lines in the sense of Euclidean geometry
	Lobachevskian parallel postulate	lines in the sense of Lobachevskian geometry
	Riemannian parallel postulate	lines in the sense of Riemannian geometry
[DUCK/RABBIT FIGURE]	Duck-Culture postulate	recognition of a duck as reality
	Rabbit-Culture postulate	recognition of a rabbit as reality
[LANGUAGE]	viewpoint to articulate words	languages
[WORLD]	worldview	object systems
[SCIENCE]	worldview woven into language	knowledge systems
[SCIENCE EDUCATION]	worldview woven into L-C Setting	language modes of science education

In the table above, the indefinable term [DUCK/RABBIT FIGURE] may sound odd, because it is not a term but a figure. However, this figure plays the same role as

indefinable terms for the reason that nobody is allowed to interpret the figure into anything at the axiom stage of cognition. And regarding [LANGUAGE], Kawasaki (1996) discusses how actual languages are organized by viewpoints on the basis of structural linguistics.

Subjectivity-Consciousness in Science Education

Normally, countries as political units establish their respective national education systems. Those countries are properly thought to be nation states. In each nation state, the use of the dominant language is generalized through its national education system. By means of the dominant language as a national language, each nation state has its national literature and history written in the national language (Kohn, 1973, p.324). Since a specific worldview is woven into the national language, it becomes possible to foster national identity in pupils' mind. They share the same worldview. This is the principal reason why every nation state claims responsibility for its national education. Although this idea of nation state is simplistic (e.g., omission of friction among sub-nations with different languages or worldviews in a nation state), every political unit models or intends to model the idea of nation state in the present time.

In addition to the three features above (i.e., a national language, literature and history), every nation state intends to introduce W-science and technology.

> [Thus] nationalism is closely linked ……, with the introduction of modern science and technology in the service of the nation, with the exaltation of the national language and traditions above the formerly frequent use of universal languages (in Europe Latin and later French) and universal traditions (Christianity and Islam). (Kohn, 1973, p.324)

This is the reason that science education (i.e., teaching W-science) is upheld globally and conducted in various languages. However, this gives rise to friction between worldviews in non-SAE language modes of science education.

In every non-SAE language mode of science education, pupils are led inevitably to conceptual confusion about W-scientific concepts or reality, as in the Japanese language mode of science education. There, science teachers are so enthusiastic about teaching W-science that they regard the non-SAE worldview, by which pupils acquire actual meanings in their L-C community, as impediments to pupils' learning of W-science. Science educators are inclined to emphasize the superiority of the W-scientific worldview to the non-SAE worldview concerned.

This outlook of science educators on the W-scientific worldview is inconsistent with the nation state objective of fostering national identity in pupils' minds. Therefore, the question of how to reconcile the W-scientific and each non-SAE worldview should be considered in non-SAE language modes of science education. The reconciliation will start with science educators' realizing that pupils are experiencing conceptual confusion; then, their endeavour to eliminate the confusion will follow.

The reconciliation involves not only the W-scientific but also the non-SAE worldviews, both of which are at the postulate stage of cognition. Therefore, it is necessary to differentiate these two worldviews; then, language modes of science education will be differentiated by means of the present axiomatic system. This leads science educators to a language related strategy for conducting non-SAE mode of science education: science education should be associated with *foreign language education*

(Kawasaki, 1996). Foreign language educators make a deliberate differentiation between pupils' first language and the foreign language to be taught, and naturally differentiate the worldviews woven into the respective languages.

In science educators' differentiation, no sense of discrimination in the science classroom should be made. This is achieved with the aid of Axiom (1), which reminds them of the transcendental nature of worldview as a postulate. It should be emphasized that the worldview is transcendental: it lies beyond practical experience of the people in each L-C community. The worldview cannot be proven by facts or practical experience as can the L-C phenomena. To the contrary, these facts or practical experience become discernible on the basis of the worldview (Suzuki, 1993, p.40). This is very similar to the geometrical facts: any postulate cannot be proven by theorems.

Because the W-scientific worldview is not an exception (see Kawasaki, 2002), this transcendental nature of worldview makes it possible for science educators to relativize W-scientific worldview to all other worldviews. This is identical to ensuring the equity of sciences at the theorem stage of cognition. Those science educators who ensure equity will not replace the non-SAE worldview by the W-scientific worldview, but just contrast one with the other. Thus, science educators should keep the two worldviews in perspective in non-SAE language modes of science education.

This means that any cross-cultural study should be conducted at the postulate stage of cognition, not at the theorem stage. For example, I have elucidated the L-C incommensurability between "nature" and "shizen", and have reduced this L-C incommensurability to the linguistic fact that only the English language (as a typical SAE language) has an established function to form abstract nouns (Kawasaki, 2002). This L-C incommensurability is revealed at the theorem stage whereas the lack of the established function in the Japanese language lies at the postulate state. The lack of the function does not mean a linguistic flaw (Kawasaki, 2002) but shows an identifying characteristic of the Japanese language. A worldview should not be judged with respect to another, because any worldview is transcendental by nature, as stated above. However, it is possible to compare with another worldview against the backdrop of Axiom (1).

The point is that, taking account of the contradiction between the two worldviews, science educators need to realize which worldview they now adopt in the science classroom. It is easy for foreign language teachers to realize which language they speak in foreign language education, but it is difficult for science teachers to realize which worldview they now adopt in non-SAE language modes of science education for the reason that the same language seems to be used. In order to accomplish this, science teachers need to develop a subjectivity-consciousness mind by conducting epistemological reflection. This entails cultivating their ability to make a choice between the W-scientific and their pupils' first worldviews and to realize the choice just made.

When science educators successfully develop this subjectivity-consciousness mind, their outlook on W-scientific objects will make a radical change from discovering them to choosing the W-scientific worldview within which W-scientific objects are articulated at the theorem stage. This change is identical with a departure from Platonism in the following sense.

> Platonism as a philosophy of mathematics is the view that at least the most basic mathematical objects (e.g., real numbers, Euclidean squares) actually exist, independently of the human mind which conceives them. Their properties are discovered, not created. (Anglin & Lambek, 1995, p.68)

Taking account of the similarity between mathematical objects and W-scientific reality in the sense of Platonic Ideal (Kawasaki, 2002), the subjectivity-consciousness mind will remind science educators that W-scientific reality is created at the theorem stage of cognition. Those science educators will realize which worldview is chosen in a non-SAE language mode of science education. Hence, L-C incommensurability will come under science educators' control.

At the end of this section, I adduce two possible factors which make it difficult for science educators to realize the difference in worldviews at the postulate stage of cognition. One is the translation-origin factor due to the container-contents model of language (Kawasaki, 1996), as stated earlier. Because the container-contents model claims that language and worldview are separable, science educators tend to pay no attention to the difference in worldviews when translating W-scientific terms. In this process of translation, science educators unwittingly transform W-scientific concepts in accord with the non-SAE worldview, thereby contradicting the W-scientific worldview at the postulate stage. Consequently, the counterparts do not play the same role as in W-science at the theorem stage. As a result, the counterparts will inevitably deceive science educators and then their pupils (Kawasaki, 1996; 1999; 2002).

The other factor is many science educators' belief in the universality of W-science. The axiomatics model, which reveals the transcendental nature of worldview, will be useful for science educators' reassessing their belief. Usually, by emphasizing the universality of W-science in the Japanese language mode of science education, for example, science educators are inclined to think it right that the Japanese L-C worldview should be replaced by the W-scientific worldview. The present axiomatics model will remind science educators that any worldview as a postulate should be treated equitably because of its transcendental nature. Those science educators who become conscious that the Japanese worldview should be neutral toward the W-scientific worldview will need a base of equitable comparison between them. The base is at the axiom stage of cognition, and the possible axiom system will consists of axioms (1) and (2).

Toward Worldview Education

Science educators with a subjectivity-consciousness mind will naturally develop the idea of worldview education from any type of language mode of science education. Then, worldview education will become an essential aspect of non-SAE language modes of science education. By focusing on differences between the two worldviews concerned, science educators keep them in perspective. These two worldviews are the W-scientific worldview and the worldview woven into pupils' first language. In worldview education, pupils will learn that every L-C reality, not excepting the W-scientific reality, is created by a worldview beyond practical experience. And they will become able to reduce L-C incommensurability to the differences between the worldviews. Then, pupils will learn W-science and their science, both of which are at the theorem stage, without any L-C prejudice.

As a result of worldview education, pupils will get the key to "a prison formed by the structural rules of our language" (Popper, 1994, p.52). Popper commented on this metaphor:

> I am prepared to accept this metaphor, though I have to add to it that it is an odd prison as we are normally unaware of being imprisoned. We may become aware of it through culture clash. But then, this very awareness allows us to break out of the

> prison. If we try hard enough, we can transcend our prison by studying the new language and by comparing it with our own. (Popper, 1994, p.52)

Worldview education will be able to arrange "culture clash" for pupils. They will become aware of "being imprisoned," and will get the key to "the prison."

This means that drawing pupils' attention to their conceptual confusion is identical to resolving their conceptual confusion. Those pupils who can get the key will successfully avoid their L-C identity crisis in the science classroom. Hence, science education will set forth a new objective in addition to W-science teaching: worldview education wherein pupils learn W-science with a subjectivity-consciousness mind by means of the axiomatics model. Worldview education will also liberate science teachers from "the cultural myths of modernist science, not through rejection, but, rather through critique that makes visible historical contingency" (Taylor, 1998, p.1121).

Pupils in worldview education will find themselves not obeying their worldview as a social norm but making an independent choice of their worldview at the postulate stage. Whether pupils obey or choose the results may be the same from the viewpoint of their learning W-science. However, those pupils will regain their freedom to make a choice of worldview in non-SAE language modes of science education because they have the key to the prison of language, that is, worldview. They will not suppress the worldview woven into their first language.

Consequently, pupils will not replace their inherent worldview by the W-scientific worldview, and will find a difference in worldviews at the postulate stage. After reducing L-C incommensurability at the theorem stage to the difference between worldviews, pupils will become able to learn both sciences without prejudice. Thus, reconciliation will be brought about in pupils' minds. This means that both teaching W-science and fostering pupils' national identity will be accomplished in the science classroom. It will be confirmed that how to realize is synonymous with how to resolve.

Furthermore, the axiomatics model will stimulate science educators to undertake a mirror argument in the context of worldview education. A mirror argument always presupposes another one in which the first person and the second person are exchanged. They are mirror arguments to each other. For example, Kawasaki (2002) mounted an argument in which the author as a non-SAE language person discussed non-SAE language modes of science education against the backdrop of the W-scientific worldview. The mirror argument to Kawasaki (2002) will be: An author as an SAE language person discusses an SAE language mode of science education against the backdrop of a non-SAE language worldview.

In a pair of mirror arguments, an object of consideration will be exchanged as follows. From the viewpoint of a non-SAE language mode of science education, on the one hand, the W-scientific worldview is objective and corresponds to a foreign language in foreign language education. On the other hand, from the viewpoint of the SAE language mode of science education, the W-scientific worldview is subjective and corresponds to the first language in foreign language education. The axiomatics model will make possible the pair of mirror arguments.

It may be concluded that a non-SAE type of worldview should be learnt equitably even in an SAE language mode of science education. Then, the pair of mirror arguments will be completed. If science educators pay more attention to worldviews woven into various non-SAE languages, a lot of pairs of mirror arguments will be made. Definitely this will bring great improvement in the fields of science education and science education research. Then, in worldview education conducted throughout the world, pupils will learn W-science and at least one non-SAE science. If science educators realize that W-science

is at the theorem stage of cognition, W-science will appear to regain universality to a certain extent.

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COUNTRY REPORTS

Malaysia

LCI influences on children's understanding relating to germination of seeds

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Abstract: *This study was carried out to examine language and cultural incommensurability (LCI) relating to germination of seeds among Malay children. Specifically the writer is interested to find out if there exist variations in understanding of terms related to germination below despite the participants having chosen from the same culture, religion, and similar socio-economic background. Thirty Malay children attending two national primary schools located within the same township participated in the study. It was found that the children possess a myriad of understandings of each of the concepts examined, indicating that linguistic and cultural elements do influence the formation of conceptual understanding as well as the way meaning is assigned to each of the concepts.*

Introduction

The vital role that language plays in the dissemination and acquisition of knowledge has been highlighted by many researchers. Postman & Weingarter (1971) argue almost all of what we customarily call 'knowledge' is language. By that, Postman & Weingarter mean that the key to understanding a subject is to understand the language used. Halliday (1973) further accentuated the importance of language in learning when he wrote:

> Bernstein has shown that educational failure is often, in a very general and rather deep sense, language failure. The child who does not succeed in the school system may be one who is not using language in ways required by the school (p.10).

In the teaching of science and mathematics, the crucial role that language play is often sidelined or went unnoticed. It is not uncommon that a science or mathematics class commences and is carried out with the assumptions that children use and therefore hold relatively similar understanding as their teachers.

Previous language-related issues in science education

Although somewhat taken for granted, previous researchers did not totally ignore aspects of language in science learning. Specifically, three main areas related to language in science learning have been examined. They are:

Discourse-based aspects of language in science learning

Researchers like Brown & Campione (1990, 1994), Mason (1996), Glasson & Lalik (1993), Halliday & Martin (1993), Hogan & Fisherkeller (1996), Peacock (1991) and Rivard & Straw (1996) were not only in agreement that communication is an integral

aspect of inquiry in science by which learners can reach more advanced levels of understanding but they also stressed the importance of literacy - the ability to read, write and use precisely scientific terminologies - in learning science. Osborne (2002) succinctly emphasises the need for students to be able to understand and use language, including scientific terminologies, appropriately when he stated:

> …[if] we wish students to gain insights and understanding of the manner and nature of scientific reasoning, we must offer them the opportunity to use and explore that language, i.e. to read science, to discuss the meaning of its texts, to argue how ideas are supported by evidence and to write and communicate in the language of science. (p.204).

Language as a psychological tool in science learning

Other than aspects of literacy, there were groups of researchers who became interested in science learning and understanding as the outcome of intricate processes involving the formation and organization of individual thought and mental structure. Specifically, the works of Piaget (1959) and Vygotsky (1989) spurred deep interests to examine the nature of mental representations of science objects as well as the means by which meanings and concepts are produced. In-depth investigations on the meaning and conceptions of diversified science concepts were carried out, followed by studies examining how concepts are exchanged (Hewson, 1981), accumulated (Posner *et al.*, 1982), restructured (Carey, 1985), enriched (Vosniadou, 1994) and modified or replaced (Bruner & Haste, 1987) in response to social change.

Language as cultural tool in science learning

In addition to its role in the construction of conceptual understanding and in the formation of meaning, language in science learning is also viewed as a cultural tool necessary for sharing and developing knowledge. Language mediates thinking by imparting meaning to actions (Duran et. al., 1998); it is a medium by which knowledge is transmitted from a more-experienced to a less-experienced member of a given culture (Vygotsky, 1989) as well as a means "…for thinking together, for collectively making sense of experience and solving problem" (Mercer, 2000b, p.1). In science, the specific use of language often accompanied by the use of diagrams, pictures, chemical and mathematical symbols and equations, gestures and texts also helps inform others in a meaningful way what a concept or a phenomenon is.

One may learn in isolation. However, knowledge acquisition usually involves other people. Often, we learn with others and from others. When children learn as a group, it is expected that they share similar understanding of was taught. However, the works of Jegede (1997), Ogawa (1995, 1998), Kawasaki (1996, 2003), Cobern (1996, 1998), and Loo (1999, 2001) have shown that learning science involves much subjectivity largely contributed by the worldview of the learner. Worldview here refers to common concept of reality shared by people belonging to the same culture. Whilst the people from the same culture (often within the same society) may relate to, understand and express similar beliefs to one another, each individual however possesses his or her own 'culture in the head': areas that make one person different from another. The variations are largely the result of experiences, observations, analysis, actions as well as interpretations of those experiences and the outcomes of experiences. Hence, it would not be surprising to find a group of students from the same classroom, drawn from the same culture to have diverse

understandings of a particular concept despite receiving exactly the same instruction. The differences in understanding herewith may be referred to language and culture incommensurability or LCI.

The Study

The findings reported here are part of a bigger study that aims to investigate children's conceptions relating to germination of seeds. The children involved in the study resided in an urban township located in the Klang Valley and attended national primary schools. Each child was asked to draw his or her context map of germination of seeds and interviewed twice, one before and another after formal instruction. All science lessons pertaining to germination were also observed to determine how teachers' understanding of the understudied concept interacted with those of their pupils'. Science, for these children, was taught and learned in the national language, Bahasa Malaysia.

For this paper, only responses of the Malay children are reported despite the inclusion of Chinese and Indian children in the main study. A total of thirty (n=30; Male = 14; Female = 16) Malay pupils participated in the study. The linguistic and socio-cultural influences on the Malay children's understanding are also examined and discussed. Specifically, three concepts relating to germination of seeds were examined. They are:

Table 1: Germination-related concepts examined

Science Concepts	
in English	*in Bahasa Malaysia*
seed	*biji benih*
germination	*percambahan*
food	*makanan*

Although the writer did not specifically ask the children the language they predominantly use at home, their preferences when responding to the interview questions suggested that the majority used their mother tongue – Malay. However, about a third of them were actually more at ease replying in English, an indication that English language may be used as commonly as the Malay language, if not more, in these children's homes.

Children's Understanding of Concepts Relating to Germination of Seeds

The discussions on the meaning and on the children's understanding of each of the three previously mentioned germination-related concepts are as follows:

Seed

The Malay word for seed is '*biji benih*' which is a combination of two words, namely '*biji*' and '*benih*'. Depending on the context in which the word is used and encountered, the term '*biji*' may refer to any of the following:

- The part of a fruit that is quite hard and can be planted

- Small or very tiny fruits (like the size of berries)
- Private part or genitalia
- Quantifying adjective (word describing noun; i.e. lima *biji guli* means five marbles)

The term '*benih*' on the other hand could refer to:

- Fruit part which can be planted
- Something that can spawn a living being (besides seeds may include sperm, ovum, spores and egg)
- Source (of something)
- Descendant
- Pertaining to emotion

In the Malay community, it is fairly common for a person to use the word '*benih*' alone to refer to a seed.

When asked what they know about seeds, eleven (37%) of the children were unsure what seeds are while another nine (30%) had no idea at all. For these children, their lack of understanding of seeds may be due to a couple of reasons, first of which is the lack of exposure to seeds and other seed-related or seed-producing objects and concepts like fruits and plants. Second, it is likely that they are familiar with fruits and plants but i) were not exposed to the term '*biji benih*' or 'seed' or ii) may have heard of the terms ('*biji benih*' and/or 'seed') before but do not know what they refer to. There were several children among those uncertain what seeds are who referred seeds to '*kacang*' (beans) and to the 'inside part of fruits' when asked to describe what they knew about seeds.

The remaining ten of the children claimed seeds refer to anything that will grow if planted (n=7; 23%) and something containing mini plants inside them (n=3; 10%). These understandings of seeds are probably expected out of the children had they acquired the definition of '*biji*' as 'the part of a fruit that…can be planted' or '*benih*' as 'something that can spawn a living being'. However, their notion of seeds as 'anything that grows if planted' is also dependent on their previous encounters (be it through personal experience in handling, reading about, or watching others) of the growing objects. Among the items identified as seeds include objects that reproduce by asexual mean such as onion, potato and ginger. Fruits such as a lime and part of a fruit/vegetable like a corn cob were classified as seeds as well because the children believed that they can generate a plant if sown in the soil.

The children's understanding of seeds did improve after formal instruction. They were in agreement that seeds refer to something which will grow and become plants given the right requirements and environment. They were also more aware of seed origin and knew that besides seeds, plants have different procreation mechanisms namely using bulb, seedling, stem cuttings, etc. However, none of the children provided the scientific understanding of seeds as the product of the success or failure of pollination. Neither were they aware that in a viable seed is a living embryo consisting of undifferentiated cells that will start to differentiate and develop during the germination process. The majority of the children remained uncertain about the nature of thing inside seeds that eventually grows.

Germination

Similar to the term '*biji benih*' or 'seeds', the children's understanding of germination is equally minimal. Only eight of the participants (28%) were familiar with its Malay term '*percambahan*' which is formed from the root word (*cambah*) with a prefix (*per*) and suffix (*an*) while the rest of the children have never heard the word before. By definition, the word '*cambah*' refers to a small plant that has recently emerge from within a seed (Kamus Dewan, 1993). When the prefix (*ber*) is added to the root word (*cambah*), the word '*bercambah*' may mean any one of the following:

- Beginning to develop (*tumbuh*)
- Having a part of a plant emerges
- Appear/being born/emerge or rises (as in the sun rises)
- The presence of something en mass; to become greater in number (a lot)

The fact that they have never heard of the specific terminology '*percambahan*' prior to formal instruction does not necessarily mean that the children knew nothing about how plants come into being. Further probing on their understanding of how seeds grow generally revealed two patterns of understanding relating to germination. First, the *tabula rasa understanding* refers to a state whereby the children involved have no idea at all how plants came into existence. Nine (30%) of the children fell within this category. Second, the *partial understanding* of germination views the growth of a plant when

<u>something deemed as a seed is planted</u>.

Among the items perceived as seeds by seven (23%) of the participants include any part of a plant (such as the bulb, shoot, root, fruit, etc) or anything from within a seed.

<u>something inside a seed grows.</u>

The remaining fourteen (47%) of the children identified the 'thing' inside the seed that eventually grows as either a mini version of a fully-developed plant or something else inside the seed but its exact nature is unknown.

In place of the specific definition of '*percambahan*' or 'germination', the children instead provided superficial responses like '*tumbuhan*' (plant), '*bertumbuh*' or '*keluar*' (emerging), and '*tumbuhan bertumbuh*' (plant emerging) when asked what they knew about germination of seeds. The very reasons why the participants responded as such to the question "*What do you understand by germination?*" may be due to the overlapping meanings of the word 'plant' with the various germination-related descriptions in Malay described earlier. The Malay word referring to a plant is '*tumbuhan*' which is formed from the root word (*tumbuh*) and the suffix (*an*). By itself, '*tumbuh*' denotes

- to gradually grow or develop
- to become big
- to grow upwards
- to emerge or to rise (as in the sun rises)

To recapitulate, '*bercambah*' (germinate) which means 'beginning to develop' or 'having part of a plant emerging' is synonymous with the above definition of '*tumbuh*' (grow).

Many Malay children, and even adults, are not aware that '*bercambah*' actually precedes '*tumbuh*'. Instead, they commonly use the two words interchangeably.

Similar to their understanding of seeds, the children's understanding of germination after formal instruction also improved. All unanimously agreed that germination refers to the growth of something from within the seeds upon receipt of germination's basic requirements but their opinions differed with respect to the nature of the 'thing' that grew. Table 2 lists the children's post-instruction perceptions of what grows from inside the seed during the germination process.

Table 2: The frequency of children's perception of what grows from inside the seed during germination process after formal instruction

Nature of the 'thing' that grows	**Frequency (%)**
ALTERNATIVE CONCEPTION 1: **Seeds that grow have something inside but the nature of the 'thing' is uncertain**	**24 (80)**
"Small stuff"/ " tiny, tiny thing"	*1 (3)*
"Root"	*2 (7)*
"Seed"	*1 (3)*
"Something whitish/white color thing"	*4 (14)*
"Don't know how to describe" / "Don't know how to tell"	*16 (53)*
ALTERNATIVE CONCEPTION 2: **Seeds that grow have a mini version of fully grown plant inside**	**6 (20)**

It was also noted that much of the children's alternative (incorrect) understanding, be it of seeds and of germination, was contributed by the children's respective science teachers during formal instruction. The drawings and notes written on the board as well as references used as teaching tool may have misled children to an understanding that is different than what was intended. For instance, Figure 2 which shows a plant emerging from inside a seed may suggest that there is indeed a 'fully-developed mini plant' inside seeds that is waiting for the right conditions for it to surface. The picture also suggests that the seed remains (continue to exist) long after germination ceases and growth has taken place.

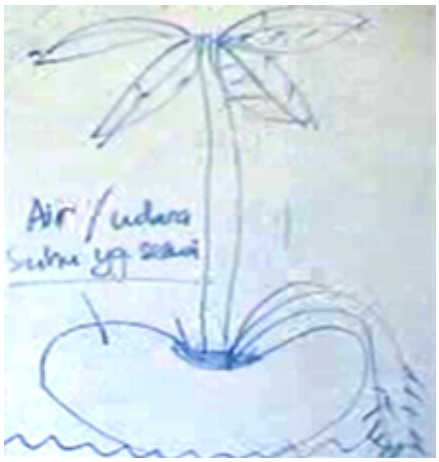


Figure 2: A picture of a germinating seed drawn and used in one formal instruction

Similarly, the science textbook used as reference to enhance children's understanding of germination process may contribute towards the understanding of a mini plant emerging from within the seed.

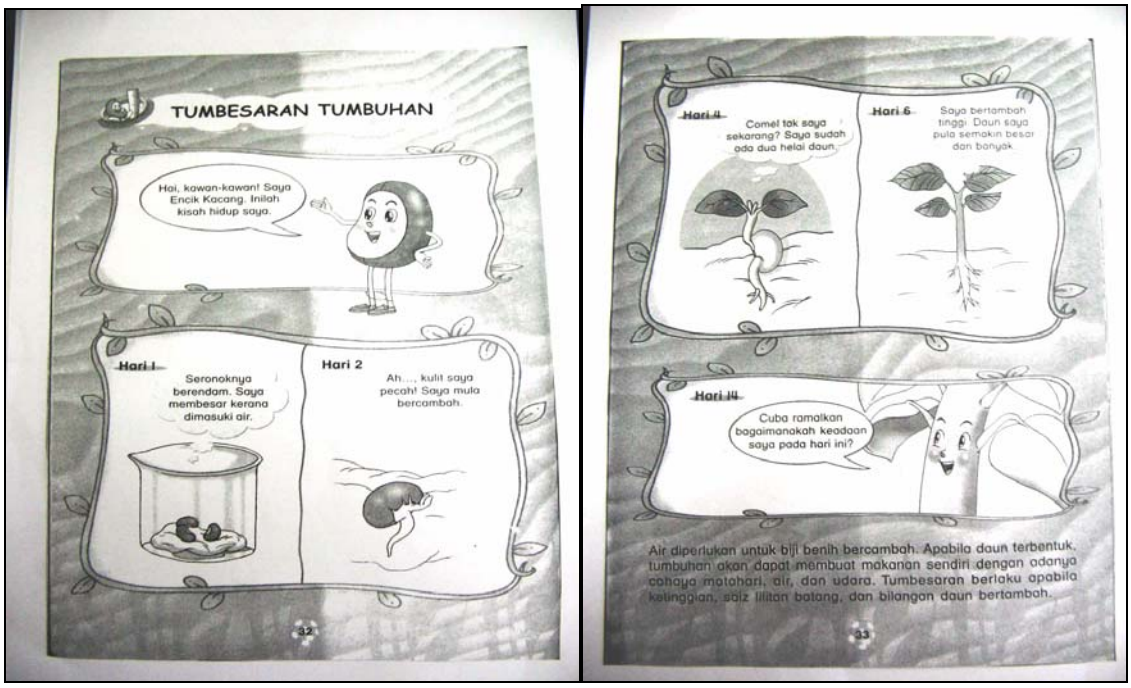


Figure 3: Pictures of germination process from a science text used in formal instruction

Figure 3 highlights yet another teaching approach which may possibly contribute towards misunderstanding of the concepts understudied.

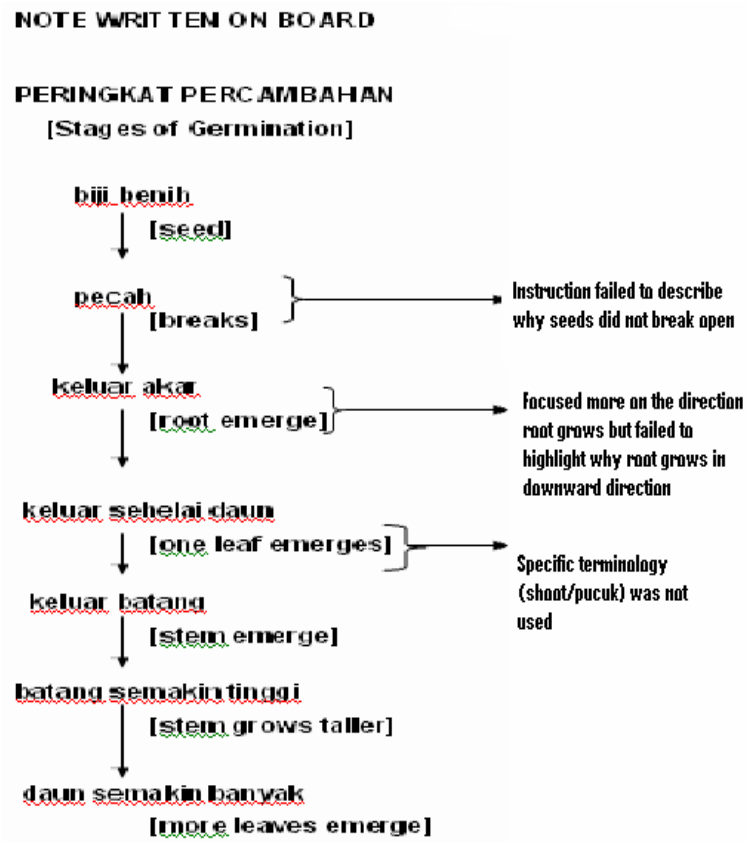


Figure 3: A flowchart showing stages of seed growth drawn during a formal instruction

Food

When describing their understanding of the food source used by seeds during germination, it was noted that the children held the understanding of 'food' or '*makanan*' as something with an extensive quality – meaning something from the outside that is consumed and eventually internally digested. None of them was aware of the fact that seeds' sustenance is located inside the seed. Among the answers given by the children in response to the question "*Where do seeds get their food from during germination*?" include soil, water, air, fertilizer, sunlight and worm. These responses were somewhat expected due to the everyday meaning the Malays assigned to the word "*makanan*". Having originated from the root word (makan), '*makanan*' refers to any of the following:

- To eat or to chew
- To use up something (i.e time, money, etc.)
- "rezeki" (a Malay word with incommensurable translation meaning something bestowed by God; it may come in many forms and kinds including tangible or material thing like money and other worldly goods; in the form of being like a son or daughter; in the form of good luck; etc.)

(Source: Kamus Dewan, 1993)

When combined with the suffix "*an*", the word "*makanan*" refers to:

- Anything that can be eaten
- Something that fills up a person (usually food)

- Something edible that can be easily prepared

Note that all of the above meanings of '*makanan*' suggest something which is consumable. For the majority of the children, seed sustenance being internally stored and even more so being used up is not only difficult to visualize but also to comprehend since it would be against how they generally obtain and consume theirs. The difficulty for young children to comprehend internally stored food (or cotyledon) is evident whereby there were participants who, after formal instruction, attained incorrect understanding of the concept. Although they may correctly state the definition of cotyledon, the children failed to grasp full understanding of the concept and could not respond accordingly when asked what happens to the cotyledon throughout the germination process.

Terminologies with everyday meaning

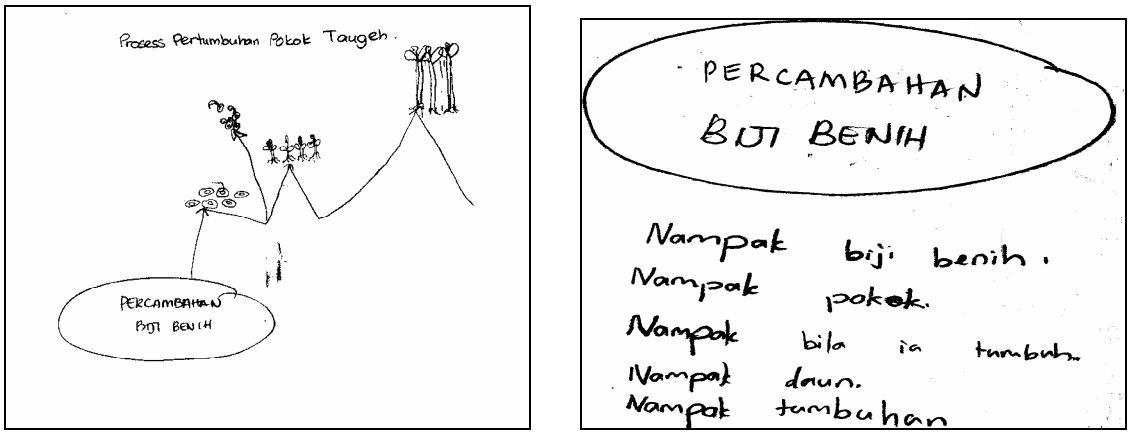
Besides 'food', there were other terms with both specific (scientific) and daily meanings. One glaring example is the word 'leaf'. It was discovered that some of the children used the word 'shoot' and 'leaf' interchangeably to refer to 'leaf', having little understanding that shoot specifically refers to the first or the primary leaf that emerges during germination. The same misunderstanding was observed in the responses of the children regardless of the language used during the interview. For instance, those who predominantly used the Malay language when responding to the interview questions were also discovered using the word 'daun' (leaf) to describe 'pucuk' (shoot). Several other children also used the word 'batang' (stem) to refer to the plant's stem, bark and even the branch, possibly because there is no specific word to differentiate the stem and the bark in the Malay language (the Malay refers to both stem and bark as 'batang').

Discussion

Based on the children's responses, it could be deduced that their understandings of the concepts "seed", "germination" and "food" tended to be based on what was perceivable, intelligible and, perhaps most importantly, familiar. The children whose descriptions of "seeds" include "bean", "fruits" and "part of plants" must have acquired those notions of seeds from another person (parents, teachers, peers) or from a different source of information (the media), and have probably used those words before without anyone else pointing out to them that their understandings were incorrect. Similarly, those who called the stem, bark and branch of a plant "stem" must have heard others use those terms or read about them but failed to take note of the exact plant structure being referred to.

Here, it is crucial to point out that the meaning one assigns to and the understanding one has of an object is largely the outcome of how language is used to describe the object during the first and subsequent encounters. For instance, it was discovered that there were a couple of respondents who were told, later believed and eventually referred to "fertilizers" as "seeds". In other words, how word is assigned to describe an object does shape conception and influence understanding. It was noted that children generally assign a word or a term to a physically perceivable object. However, the children will not respond to or totally avoid questions on things which they are unfamiliar with or have never seen before (i.e seeds for those categorised as possessing *tabula rasa* understanding) and those not immediately perceivable (i.e there exist food store in seeds).

Often, one word may carry more than a single meaning within the same culture. Even then, the supposedly same meaning held by Malay Boy 1 (MB1) would still be different than the meaning possessed by Malay Boy 2 (MB2) mainly due to variations in their i) conceptual schema and ii) associations or links formed between the core concept and those at the periphery. The context maps below depict variations in the understanding of concept "germination" between the two male respondents in this study.



MB1 MB2

Figure 3: Context maps of germination drawn by two male participants

What is obvious about the above is that both participants shared some aspects of seed germination understanding (like seeds grow) but what were in their minds and how those information were represented differ.

It could also be that what is understood is dependent on which conceptual schema is activated. The activation of a conceptual schema, however, is dependent on the language the children predominantly use at home or the language in operation when discussing a particular concept. For example, a child who primarily uses English as a means of communication at home may activate different sets of conceptual schema for 'seeds' as he/she searches for the relevant translation upon initial encounter of the word '*biji benih*'. Since these pupils learn science in Bahasa Malaysia, there is the possibility of them encountering what linguists term as "L1 interference". L1 interference refers to the acquisition of different meaning and understanding of a concept than the one intended resulting from double translation: once from the Malay word into English (to initiate thinking process of the term) and another from what is understood in English into Malay (for the purpose of conveying their understanding of the concept). For these children who are more prone to thinking and using English as their primary language of communication, a different issue may arise. Their inability to describe a concept in Malay, for example, may also be hampered by their semantic deficiency or lack of vocabulary. As a result, it may appear that they do not understand the concept being taught.

Nonetheless, for the germination-related concepts examined in this study, L1 interference did not influence too much on the participants' understanding. Given the context of plant growth, the word 'seed' as defined by Kamus Inggeris-Melayu Dewan, 1992) generally carries similar meaning to its Malay term '*biji benih*':

- The hard part of plant from which new plant can grow; usually found inside the fruit
- Used for planting
- A means of propagating plants

- Beginning (of something)

Hence the effects of linguistic incommensurability resulting from translation here was not clear cut. Instead, there were indications of cultural influences - specifically the influences of culture at home – on the understandings of the three examined terms relating to germination. Culture at home here means the lifestyle, household management and children's involvement as well as the way they were brought up. Urban living style which confines space for planting trees at home brought on the preference less time- and effort-consuming (such as buying potted plants instead of sowing seeds and care for the developing plant) activities and characterized by consuming instead of producing culture prohibited the children from exploring seed planting and plant growing activities. Their lives too are being overly sheltered whereby they are hardly asked to help with the household chores and are neither allowed to play or experiment around in the garden. In short, the ways they are brought up do not promote rich understanding of seeds and plants which otherwise should be familiar to them.

It was also highlighted that instructional approaches and influences to explicitly communicate the right conceptions also contribute to the children's varied understanding of the understudied concepts relating to germination.

Conclusion

This study underlines the importance of language in shaping children's conceptions, meaning and understanding of concepts relating to germination of seeds before and after formal instruction. While cultural-related elements such as home environment and personal experiences remained crucial in influencing their understanding of science concept, the teachers' understanding and the manner in which lessons were carried out were equally significant.

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Science Learning via Chinese Language

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Abstract: Language-Culture Incommensurability (LCI) in science is a direct consequence of the adoption of Western-ethno science in teaching regardless of the socio-cultural background of the students. Western worldview differs significantly from the traditional Chinese philosophical thinking on the origin of life and the relationship between man and his environment; it is an issue of objectivity versus subjectivity. In learning science, the Chinese origin students would bring together with them their cultural understanding of this relationship to the classroom, thus causing possible LCI. Culture and language are closely related, the former is the consequence of the latter and vice-versa. Each Chinese word carries meaning by itself and this poses as strength as well as weakness in the learning of science. In the Malaysian-Chinese context, students generally come from two different family backgrounds: English-speaking or Chinese-speaking. The language they used to learn science formally in schools could differ from the language they used at home. They would have come into contact with one of the language first; this causes proactive or retroactive inhibition which hinders their learning of science in school. If cultural difference is the inhibiting factor in learning science, to the Malaysian Chinese the enabling factor is the ability to master the language of Western science, the English and their mother tongue, the Chinese.

Introduction

Human are social being who live in communities, very often communities of similar ethnic origin. Communities develop schools as formal institutions to educate the future generation. Medium of instruction used in these schools for teaching and learning are language agreed upon by the community for furtherance of certain objective and for achievement of greatest effect in learning. Among the common subjects taught in schools is Science. Kawasaki (2002, 2005) pointed out that science taught throughout the world is the Western Science laden with the Western worldview. Literature about the close association between language and culture are plenty. Together with the western worldview, Western Science also brings along with it idea of the pedagogies of teaching science influenced by the philosophical, psychological, sociological and environmental factors of the western world. An example is that of the study by Li (1999) which revealed the vast discrepancy between the culture of teaching on the part of the expatriate teachers who put strong emphasis on the discourse of participation and the culture of learning on the part of Chinese students who were accustomed to the discourse of teacher authority. This article aims at analyzing science learning via Chinese language and explores how various philosophical, socio-cultural and psychological factors influence or impede learning. At the same time, the authors also attempt to analyse the possible sources of misunderstandings and Language-Culture Incommensurability (LCI) (Kawasaki, 2002, 2005) arising from the translations of scientific terms in the English language into equivalent terms in indigenous language as well as the incompatibility among the western

culture and the Chinese culture. Case examples will also be reported on the inhibiting and enabling factor in learning science via the Chinese language.

Analysing LCI from the philosophical, psycho-social and cultural perspectives

This section dwells on the philosophical perspectives of subjectivity versus objectivity as well as the psycho-social and cultural influence leading to proactive and retroactive inhibition in learning. The strength and weakness of the Chinese language in learning Western science is being explored with specific.

Philosophical Theories – Subjectivity versus Objectivity

There are various philosophical explanations on how the origins and classifications of language affect one's thinking. Kawasaki (2002) uses a theoretical framework of "linguistic mode of science education" to espouse on this issue. This framework incorporates the aspects of *cultural relativism* which suggests that science educators need to accommodate the existence of different worldviews in science education. According to Kawasaki (2002) two major worldviews are in place, one focuses on objectivity, the other on subjectivity. "*Objectivity*" implies a single correct worldview in the present context (e.g. the question "what is this object?" is objectivity-conscious). "*Subjectivity*" is concerned with the question of "what viewpoint does create this system of objects?" (Kawasaki, 2002, p.4). This framework enables Japanese science educators to accomplish equitable treatment of the Japanese culture and the Western scientific worldview. The Japanese worldview on science differs much from the Western scientific one (Kawasaki, 2002). The traditional Japanese worldview on science is more subjective whereas the Western scientific worldview which is the dominating scientific worldview now hinges on objectivity. Kawasaki (2002) reiterated that his framework of the 'linguistic mode of science education' may be applicable to all non-Western countries, with appropriate linguistic interpretation. He further stressed that awareness by science educators of Linguistic Conceptual Incommensurability (LCI) is the first step toward overcoming them and identifying science education with foreign language education is the second step (Ibid., p.1). Teaching of science in many countries need to be associated with the teaching of foreign language (or second language) as in most instances the science curriculum is one which is heavily biased towards the Western worldview.

"Western ethno-science" or "Western scientific worldview" (which from henceforth would be known as W-Science) equate the study of science as 'the application of human intelligence to figuring out how the world works' (American Association for the Advancement of Science, AAAS, 1993, p.3). Growth in science and technological knowledge is the result of the accumulation of these experiences of scientists through the many centuries. W-Science education emphasizes on the gaining of experience doing science just like the scientists, conducting investigation, explaining findings and drawing conclusions. What school science offers is opportunity for students to emulate experiences of the scientists. These scientists would study the phenomena at hand objectively, detaching themselves from any subjective feelings. The physical world is there for him to experience and understand not to feel. This is very different from the traditional Chinese way of thinking.

"*Qì*"(气) is of utmost importance to Chinese in their understanding of life and the environment he lives in. One need to understand "*Qi*" to fully apprehend Chinese's understanding of medicine, diet, exercise, biology, psychology sociology, astronomy,

chemistry, geography, astrophysics, humaniteis and anatomy (Johnson, 2001). *Qi`* is defined as the basis of life, it is a word that 'seems to transcend definition going beyond words into the realm of experience' (Johnson, 2001, p.22). *Qi`* is a fundamental concept in many Chinese historical book such as *Yi` Ching* (Jonshnson, 2001). The famous *Yin* and *Yanǵ* theory also uses the basis of this movement of *Qi`*. Chinese believes that all living things require Q*i`*, in fact human beings and all other living things on the earth were produced from the Q*i`* in the universe. *Qi`* energy can neither be created nor destroyed but it can be stored. The closest metaphor of *Qi`* is "electricity". Though invisible to our human eye, but we know that "electricity" exists when we see the result of the electrical current, *Qi`* works the same way. However *Qi`* cannot be related to "electricity" literally because *Qi`* is also spiritually and directly related to our mind. Chinese believes that when the mind is at ease, *Qi`* is in harmony and the body is well. *Qi`* blockages is caused by physical maladies as well as emotional disturbances and can lead to health problems and death. *Qi`* is also the commander of the blood, when *Qi`* moves, blood circulates, once *Qi`* stopped, blood movement also stopped. The concept of *Qi`* does not exist in the W-Science, the nearest translation would be "vital energy". But *Qi`* is more than that, it encapsulates feeling and has to be experienced. The world is a big *Qi`* field and our own body is our own small *Qi`* field, our existence and the nature/world are all intertwined and in unity as *Qi`* flows. As an example, Chinese traditionally believes that pearl is formed after the clam absorbs *Qi`* for a long time, jade is produced when rock absorbs *Qi`* for a long time. One can't understand the world or nature by detaching from it. Our life and the environment have to be understood subjectively not objectively as W-Science proposes.

Teaching W-science to a Chinese community acculturated in traditional Chinese culture could cause Linguistic Conceptual Incommensurability, LCI as the West and the East looks at the fundamental of life and relationship between human and nature differently. This differences which stems from the issue of objectivity versus subjectivity has wide and serious implications onto science education. These different worldviews have created two categories of languages too, the dualist and the monist. The dualists coded language such as English is suitable for positivistic study which define things as what it is and what is not and where the exception makes the rule. The monist coded language such as Chinese does not consider being and not-being as inseparable, in monism, all reality, natural and spiritual are inseparable, thus in Chinese language *tian* and *ti`* (heaven and earth), *kuiˇ* and *sheń* (ghost and god) are often used together as a phrase.

There is a big difference between the traditional Chinese understandings of the world compares to the W-science. Traditionally, Chinese looks at the whole universe in unity, they tend to analyze natural phenomena in a holistic manner. The modern western world analyzes scientific phenomena by breaking it down into parts first before synthesizing them into postulates, theories or laws. However, even though the study of the natural world has started in China since the ancient age, it has never developed into a discipline as organized, well-documented, thorough and vigorously tested empirically and as well spread as the Western Science. Thus, the science that is taught in the world as well as in China is the Western Science. The Chinese science (if there is one) is embedded into studies of Chinese medicine, *fenshui*, *qigong* etc. The Chinese has immigrated to various parts of the world since centuries ago, with them they brought along their language and culture. In the foreign land their language and culture has also been partially acculturated with the local language and culture. Thus, in discussing the use of Chinese language by these Chinese ethnic groups such as in Malaysia, it need to be noted that the culture they practiced would have differed slightly from the original culture of the ancient Chinese

from the mainland China. In the modern world where technologies have facilitated and hastened cultural exchange, the culture shared by the human race especially in major towns might have been so integrated that one can't look at a Chinese and thinks that he or she would possess the traditional Chinese world view of science.

The Use of Chinese Language to Learn W-science

Abstract nouns

Kawasaki (2002) pointed out that the language dominating the W-Science is the English language. English language has lots of abstract nouns, something lacking in the Japanese language and Chinese language. An obvious example is the articles of 'the', 'an' and 'a', these articles can be used beautifully and usefully while discussing ideas and concepts, they do not necessary point towards specific concrete physical object but can be used conceptually to mean abstract ideas. According to Kawasaki (2002), there is no such equivalence in the language of Japanese. As Chinese language and Japanese language shares lots of similarities, thus Chinese language too lack of this facility. This hinders discourse in science concepts and ideas (Kawasaki, 2002). Since the Japanese language does not have definite ways to conceive abstract nouns traditionally, it has indirectly caused LCI that brings about pupils' conceptual confusion in science education in Japan (Kawasaki, 2002). The nature of the English language where active and passive verbs can be easily coined helped too in the discourse of science ideas, an example is the word 'observe' which can be used as 'being observed', 'observer' and 'observation'. In the Chinese language it is awkward to use it this way.

Pictographs

Chinese words are pictographs; each may be a combination of many pictures/concepts (Loo, 2005). Each word can be analysed in parts, words of related concept shares similar part. An example is woody plant, most of the name of woody plant would have the part of 木, such as pine tree (松树), rubber tree (橡胶树), durian tree(榴连树). Another example is insects, different insects would usually possess the same side, which is 虫, such as spider (蜘蛛), ant (蚂蚁), centepede (蜈蚣). There are many such examples in the Chinese vocabulary. This characteristic of the Chinese language facilitates students to make relationship, categorization and prediction of meanings and concepts.

Meaning for each Chinese Word

In the English language words are formed from alphabets. The basic of Chinese language is word and not alphabet. Each Chinese word has its own meaning. This word can stand alone and can also be combined to form compound words or terms with more elaborated meaning. More words can be joined to form phrases. The meanings of these terms or phrases are related to the meaning of each of these words, one can then make a logical or intelligent guess of the meaning of these phrase or terminology. This posts as an advantage to the learning of science. Examples of such terms are given in Table 1.

Table 1: Examples of Scientific Terms Generally Used in Science Curriculum and its Equivalent Terms in Chinese Language

Scientific terms in English	*Chinese*	Meaning interpreted literally
weight	*Zhong` Liang`* (重量)	*Zhong`* is heavy, *Liang`* is amount, both term put together mean amount of heaviness.
diameter	*Zhi` Jin`* (直径)	*Zhi`* is straight, *Jin`* is path, both words put together is the straight path, when used in the circle, one can imagine it as the diameter.
area	*Mian` Ji`* (面积)	*Mian`* is surface, *Ji`* is the total or the product of the multiplication of two numbers, put together it carries the meaning of total surface.
volume	*Rong´ Liang`* (容量)	*Rong´* is ability to contain, *Liang`* is amount, put together the term give an impression of amount that can be contained.
average	*Ping´ Chuin* (平均)	*Ping´* literally means flat, *Chuin* literally means equal share, put together the term gives an impression of equal share.
square	*Zhen` Fang Xing´* (正方形)	*Zhen`* is upright, *Fang* is square (having four sides), *Xing´* is shape, put together it carries the image of a four sided shape which is upright.
rectangle	*Chang´ Fang Xing´* (长方形)	*Chang´* is long, *Fang* is square, *Xing´* is shape, putting them together tells us that the shape is a long square.
triangle	*San Jiaoˇ Xing´* (三角形)	*San* is three, *Jiaoˇ* is angle, *Xing´* is shape, put together it carries the image of a shape with three angle.
Solid	*Gu` Thiˇ* (固体)	*Gu`* is fixed, doesn't change shape, *Thiˇ* is body, put together it means a body which is fixed and doesn't change shape.
Liquid	*Ye` Thiˇ* (液体)	*Ye`* is things that flow like water, *Ye`* by itself means liquid too, *Thiˇ* is body, any terminology related to liquid would contain the word *Ye*.
Gas	*Qi` Thiˇ* (气 体)	*Qi`* is things that flow like air, *Thiˇ* is body, put together it means a body that is like air.
Reflection	*Fanˇ She`* (反射)	*Fanˇ* is the opposite, *She`* is shoot, put together it gives an impression of something shooting in the opposite direction.
Refraction	*Zhe` She`* (折射)	*Zhe`* is slanted, *She`* is shoot, put together it gives an impression of something shot out which is slanted.
Transparent	*Thou` Ming* (透明)	*Thou`* is see through, *Ming´* is bright, put together it gives an impression of bright and see through.
Translucent	*Ban` Thou` Ming´* (半透明)	*Ban`* is half, *Thou`* is see through, *Ming´* is bright, put together it gives an impression of seeing through partially or partial brightness.
Opaque	*Bu` Thou` Ming´* (不透明)	*Bu`* is not, *Thou`* is see through, *Ming´* is bright, put together it gives an impression of cannot see through and no brightness.
Moon	*Yue` Qiu´* (月球)	*Yue`* is the moon, *Qiu´* is ball, put together it gives an image of moon as a ball.
Manipulated variable (Independent Variable)	*Cao Zhong` Xing` Bian` Shu`* (操纵性变数)	*Cao Zhong`* means control, doing something about it, *Bian` Shu`* literally means something that change (variable), put together it conjures an image of something that is changed and being controlled or manipulated.
Responsive Variable (Dependent variable)	*Fanˇ Ying` Xing` Bian` Shu`* (反应性变数)	*Fanˇ Ying`* is responding, *Bian` Shu`* is something that change (variable), put together it gives an image of a variable which is responding to the change

Inaccurate Terminologies

Although Chinese language by virtue of its characteristic provides meaning through the use of its words such as given in Table 1, there are also some generally used terminologies which give a different understanding if one adhere closely to the meaning of the characters. For example, the term "mammals" which serves as an abstract noun or scientific concept for Biology encompasses characteristics such as "warm-blooded, give birth, feed young with milk, with fur, etc.". The Chinese equivalent of it is "*Pú Ruˇ Tong` Wù*" (哺乳动物),which literally means "animal which feeds young with milk". This literal meaning is inaccurate compares to the definition given to mammal in the W-science. Thus, misconception might arise among the Chinese students who think that mammal means only animal who feed their young with milk. Other terms which may be the origin of misconception are given in Table 2.

Table 2: Examples of Scientific Terms in Chinese language which Might be Cause of Misconception

English language	Science Terms in Chinese	
	Terminology	Meaning and possible LCI
Flowering plant	*Xianˇ Hua Zhí Wù* (显花植物)	*Xianˇ* is seen, *Hua* is flower, *Zhí Wù* is plant, put together it is plant where flower can be seen
Non-flowering plant	*Yinˇ Hua Zhí Wù* (隐花植物)	*Yinˇ* is hidden, cannot be seen, *Hua* is flower, *Zhí Wù* is plant, put together it is plant where flower is hidden. In some textbook, *Yinˇ Hua Zhí Wù* is used to also include non-flowering plant, but literally translated, *Yinˇ Hua* is only where the flower is hidden and not that there is no flower. In some textbook, another term which is *Wú Hua Zhí Wù* (无花植物) which is plant without flower is used. Some Chinese text book said that there are three categories of plant, *Xianˇ Hua Zhí Wù*, *Yinˇ Hua Zhí Wù* and *Wú Hua Zhí Wù*, it is quite confusing especially for primary school children
Hypothesis	*Jiaˇ She`* (假设)	Literally *Tui Duan`* can mean deduce and *Jiaˇ She`* mean 'what if'. The Chinese translated words do not seem to depict the meaning of hypothesis and inference fully.
Inference	*Tui Duan`* (推断)	

The use of Chinese language to teach W-science has its advantage and disadvantage. In most cases, students benefit form the use of Chinese words because as pictographs and words laden with meaning, students can relate better with the meaning it carries. However there are terms which are not accurate in its meaning and this can cause misconception.

Social-cultural and Psychological Influences on Science Teaching and Learning

Numerous cultural and psycho-social learning theories have been used to explain the factors affecting a person's mastery of language and the learning of a particular subject such as science. This is because language as modes of communication are socio-culturally shaped (Gudykunst, 1994; Young, 1996). It has been widely acknowledged in language

acquisition research that cultural learning is an inseparable part of language learning (Li, 1999) as culture influences people's perceptions, cognition, value systems, and ways of communication (Barrow, 1990; Brislin, 1993; Gudykunst, 1994; Young, 1996). Cultural codes, accepted as "regime of truth" (Popkewitz, 1987, p.4), and therefore normative in nature, set dominant interpretative frames for the perceptions and understandings of events and new information (Scollon & Scollon, 1995; Young, 1996; Ellsworth, 1997; Ryan, 1998). In terms of science learning, apart from the learners' cultural backgrounds which influence their perceptions, as well as value systems and cognition which could be explained from psychological learning theories, the influences from their family members and peer groups, as well as the input from the formal and non-formal learning contexts are also important factors from sociological viewpoint.

Learning viewed from the 'social learning' or 'social constructivists' theories focuses on learners' prior knowledge and how they construct their understanding based on their learning *contexts*. Knowledge and understandings develop in relationship with the social context (Fickel, 2002). This type of learning is also elaborated as *social mediation* with *participatory knowledge construction* in which interaction among group members (e.g. peer group) serve as the socially shared vehicles of thought with possible support or coach from facilitator (e.g. teacher) that helps an individual to learn. Social mediation could be elaborated as, by *cultural scaffolding* [in which the emphasis is on the use of tools and artifacts e.g. books in mediating learning] and with the *social entity as a learning system* that may bring about changes in its underlying *values*, beliefs, culture and norms (McConnell, 2000). Knowledge is seen to be actively constructed, connected to the individual's cognitive repertoire and to a broader, often interdisciplinary context in which learning activities take place (Salomon, 1997).

From the socio-cultural theoretical perspectives, learning is viewed as a social and cultural activity mediated by the social and environmental factors around the learners. Thus, modes of communication are socio-culturally shaped (Gudykunst, 1994; Young, 1996). Cultural differences would therefore become potential sources of miscommunication as participants make sense of their interactions by using different interpretative frameworks (Young, 1996; Austin, 1998). This could also be explained from psychological learning theories. Research on interference theory in psychology revealed that the extent and nature of a person's experiences before and after learning are important to ascertain the success of learning. According to the interference explanation, the limited capacity of short-term memory makes it susceptible to interference or confusion between learned items. That is, when competing information is stored in short-term memory, the *resulting crowding* will affect a person's memory for particular items. For example, if someone looks up a telephone number and is then given another number to remember, the second number will probably interfere with the ability to remember the first one. Moreover, interference in memory is likely to occur when a person is presented with a great deal of new information (*Note*: This poses a lot of problems for a person to master a great deal of vocabularies, e.g. the conceptual terms in Chinese which are monist in nature, and thus it is believed that the learning of such language as Chinese should be done at an early stage in the Chinese educated culture, preferably childhood period when one's memory is in the peak stage of performance). Psychologists call these interference effects *proactive* and *retroactive inhibition* or *interference* which occur in memory when old or new information interferences with (or inhibits recall of) to-be-learned material. *Proactive inhibition* refers to the finding that old information interferes with learning new information, thus causing the decrease in accurate recall as a result of previous events interfering with a to-be-remembered one. *Retroactive inhibition* occurs when new information inhibits (interferes with) the recall of previously learned information, thus

causing the decrease in accurate recall of an item as a result of later presentation of other items. Therefore, studying French, followed by studying psychology, interferes with the recall of psychology, i.e. proactive inhibition. And studying French, followed by studying psychology, interferes with or inhibits the recall of French, i.e. retroactive inhibition (Lefton, 1991, p.223).

Chinese made up approximately 25% of Malaysia population. There are two main groups of school-going children of Chinese origins: one group goes to National Type (Chinese) primary school where the medium of instruction is Chinese and the other group goes to the National school where the medium of instruction is Malay. Among the Chinese parents, some speak to their children in English since young at home, these are the English speaking students. Some speak predominantly to their children in Chinese at home, these are the Chinese speaking students. For the English speaking students, their encounter with terms used in science would be in English first then only Chinese. The automatic recall of scientific terms in English would interfere with the understanding of the Chinese term they encountered in school *(proactive inhibition*). For example, when they see the word "*Pú Ruˇ Tong` Wù*" (哺乳动物), they might not be able to relate directly to the English term of "mammal". Beginning 2003, a revolutionary change took place in the school Science and Mathematics teaching in Malaysia, there is a switch of medium of instruction. If prior to 2003, Science and Mathematics have been in Chinese language in National Type (Chinese) Primary School and Malay language in National Primary School, from 2003, they would be taught in English in stages beginning from Year 1 in 2003. However in the Chinese Type (Chinese) Primary School, they are still taught partially in the Chinese language. For the Chinese speaking students, *retroactive inhibition* occurs when students encounter English terms and recall their understanding in Chinese. For example, when they encounter the word "sugar cane", they may directly translate as "sugar" and "cane", i.e. "tanǵ" (糖) and "tenǵ" (藤) which literally means 'the cane with sugar' [the actual word for sugarcane in Chinese is 甘蔗, "kan" (甘) is sweet and "che̋" (蔗) is the name of that species of plant]. This would cause misconception which may lay hidden in the students' mind until it is pointed out specifically to them since sugarcane has nothing to do with "cane".

The study by Li (1999) showed that cultural factors play a crucial part in participants' perceptions of their individual roles based on their cultural mindsets. These perceptions ultimately determine the styles of communication. Miscommunication occurs when different participants read the "text" differently (Li, 1999). In fact, it is especially true of intercultural communication where "the problem of intercultural understanding then becomes a problem of incommensurability between sets of rules" (Young, 1996, p.35), and where people's behavior does not seem to conform to existing values, beliefs, roles, and expectations (Cortazzi, 1990; Gudykunst, 1994). Quite often, there exists a role boundary between teachers and students in a learning institution which seriously influences teacher-student roles and expectations (Cortazzi and Jin, 1996; Craig, 1995). Cortazzi (1990) maintains that it is the degree of *proximity of the congruence* of teacher-student expectations that plays a significant role in the success or failure of language teaching and learning. The congruence, however, is difficult to achieve as teachers and students rarely share a common "agenda", even in the same culture, let alone across different cultures (Edge, 1996). The incongruence may also be caused by a language-cognition relationship, which is known as *linguistic relativity*, as stated, "all observers are not led by the same physical evidence to the same picture of the universe, unless their linguistic backgrounds are similar, or can in some way be calibrated" (Whorf, 1959, p.214). In the examples mentioned in the paragraph above, the difference in the linguistic

backgrounds for both Chinese and English speaking students is the main cause for the misinterpretation of terminologies.

Discussions of findings from case examples: identifying inhibiting and enabling factors for culturally influenced science learning

In Malaysia, there are three types of primary school: National School where there are many Malay students, National Type Chinese Primary School where students are predominantly Chinese and National Type Indian Primary School where students are predominantly Indian. Science and Mathematics were taught in students' mother tongue in these schools, i.e. Malay, Chinese and Tamil prior to 2003. These primary schools display characteristic influenced by the culture of the majority ethnic group in the school although all schools use the standardized national curriculum but translated into their own medium of instruction (other than the language subjects). However, beginning 2003, a policy has been formulated where indigenous languages will be slowly phased out and only English language will be used to teach Science and Mathematics. Lots of debate and arguments for and against this policy is still going on though the policy is into the third year of implementation. The Chinese community is split in the issue of whether Chinese or English is best to be used to teach W-science as the only kind of science that the country is teaching is the W-science. This section dwells briefly on the scenario in the predominantly Chinese community of Taiwan, continues on with some opinion from the Malaysian educators and finally exploring the inhibiting and enabling factors which might facilitate the learning of W-science in the context of the Chinese community in Malaysia.

If the use of Chinese to teach W-science does cause a certain degree of LCI, what is the situation in Taiwan where the medium of instruction is Chinese? The following excerpt is from the interview with an engineering graduate from Taiwan:

> *In actual fact, we still used scientific terminologies in English in most of our course materials in university, though we have translated books in Chinese which were mostly used to consolidate students' understanding via worked examples....* (Engr 1 graduated from Taiwan, 2005)

However, another engineering graduate has this to say:

> *Well, although the references we used were mostly in English, the medium of instructions used during lectures were still mostly in Chinese language as most lecturers and students were well-versed in this language and could understand better when they related their learning with their mother tongues and their culture or living conditions ....* (Engr 2 graduated from Taiwan, 2005)

From the excerpts above, it is apparent that the use of mother tongue in the teaching of science and technology is still the norm as it is the language which the students are familiar with. However to avoid any possibility of LCI whether it is caused by the nature of the language or its translation, the English equivalent of the terminologies used is introduced to the students. In instances like this, the operational definition of the scientific terminology is of utmost importance. In other words, to avoid LCI in the teaching of W-science, English terminologies are used. However, as it may not be the lingua-franca of the local community, it may not be feasible. The inhibiting factor in this case is the inability to master the English language and the conflict that might arise since language is

closely related to culture, the English culture might be incommensurable to the local culture. This inhibiting factor cannot be taken lightly.

If Chinese has her own philosophy on how the universe was formed and relationship between nature and human, why then aren't Chinese learn science in accordance to their traditional belief or culture? The excerpt below which is from the engineering graduate from Taiwan shed some light on it,

> *My personal opinions are.... history of China showed that most of the ancient kings of China ruled the country using the knowledge they obtained from the study of Chinese literature or philosophy (the teachings by the philosophers e.g., Meng̀ Tzeˇ, Laoˇ Tzeˇ, Confucians, etc.), and not so much using the knowledge in science and technology....At later stages, some Chinese went overseas (e.g. Russia, Europe, Japan, etc.) to study science and technology....As there was then a standardized and established W-Science and S.I. units to refer, so ....presumably.... most of the teaching in Science and Technology in educational institutions will then be based on the knowledge and terminologies or W-Scientific worldview ....I guess....* (Engr 1 graduated from Taiwan, interviewed in 2005)

In Malaysia a sizable adult Chinese population is well-versed in both the Chinese language and the English language. These Chinese adult underwent Chinese education in Chinese Primary Type School then went on to National Secondary School where the medium of instruction was English prior to 1972, a mixture of Malay and English during the period of 1972 – 1975 and after 1975 totally in Malay. Some of the Chinese population becomes proficient in both Chinese and English language due to the exposure at home where family speaks in English. How do these Chinese learn science and what are their views on the language used in learning science? Excerpts of interview are given below:

> *Of course I like to read science textbooks and references in English....But I am glad that I am Chinese educated as there are so many rich scientific knowledge to discover which are recorded in references written in Chinese language, such as Qi Gong, Chinese herbal medicine, and many more.*
>
> (Engr 3 graduated from Singapore, interviewed in 2005)

> *Well ... we like to learn science following W-Scientific worldview.... but I also like my own mother tongue, like to preserve the culture and beauty of my own native and national languages.... I don't think LCI is a big problem for most of us who are educated in Chinese language, as by being bilingual, or even multilingual in the context of Malaysia, we are able to see things more comprehensively from various angles or points of views...from the aspects of culture, values, etc....*
>
> (A group of Chinese-educated Malaysian Science/Mathematics educators, 2005)

A group of non-Chinese educators have this to say:

> *It was argued that it is easier to teach mathematical calculation table or "Cheń Fà Biaoˇ" via Chinese language as there is only one pronounciation with one Chinese character and thus it is easier to memorize the mathematical calculation table such as "Yi` Yi` Yi`, Er` Er` Si`, Qi` Qi` Si` Shí Jiuˇ", etc. It sounds easier to remember than using English translated calculations such as "one times one equals to two, two times two equals to four, three times three equals to nine, seven times seven equals to forty four", etc. ... Well, this may be one of the reasons why students from China excel in the International Mathematics Olympiads ... we presume...*
>
> (A group of Science/Mathematics educators, 2005)

Having the advantage of being bilingual, in this case Chinese and English, has facilitated the educators interviewed above to master science and mathematics. The enabling factor in this context is mastery in both the language of W-science and own mother tongue. Thus, perhaps this poses as a possible solution to the issue of medium of instruction in teaching of science and mathematics to the Malaysian as well as to communities living in other countries around the world. By being bilingual, the English language and own mother tongue, students can learn science with less conceptual confusion. There is then an opportunity for them to reconcile the incommensurability between the W-science worldview and their own culturally biased worldview, i.e. towards the restoration of subjectivity as proposed by Kawasaki (2005) as well as understanding the philosophy underlying W-science.

Conclusion, limitation and recommendations

There is a significant difference between W-science and Chinese traditional belief concerning the conception of the natural world and the perceived relationship between human and his environment. This irreconcilable difference however did not cause major conflict in the teaching of science or development of science and technology in China or the world. This is because the philosophy of traditional Chinese has so far confined itself to specific disciplines such as Chinese medicine, *qigong, fenshui, Chinese astrology,* etc. The science that has developed and established itself into a formidable discipline is that of the western science which has spread through the world. However since culture is so deeply rooted into each of our life either consciously or subconsciously, in a noticeable or embedded manner; teaching of science to Chinese need to take this traditional Chinese view into consideration lest LCI proliferate among the students and causes misconceptions which can be difficult to disentangle. The Chinese language has its strength in learning of science as each Chinese word is a pictograph and is laden with meaning in itself. However if the words used do not depict the conceptual meaning accurately, it poses weakness and can cause misconceptions which is difficult to unlearn. The inhibiting factor in learning W-science is the cultural difference between west and the local community (in the context of this paper, people of Chinese origin). However the authors found that by being bilingual in Chinese and English helps Malaysian Chinese to learn science more efficiently. Thus, the enabling factor in this context is being bilingual, mastering both the language of W-science (English) and mother tongue of the learners.

Many questions remain unanswered as studies in this area of philosophical, psychological and socio-cultural influence on learning of science by each ethnic group of the world is still few in numbers. The authors feel that in order to improve science teaching and learning, further deliberations, discussion and research in the following areas is necessary:

- Innovative student-centered strategies in teaching of science via W-science worldview with illustrations related to the students' diversified socio-cultural background and language used.
- Identify socio-cultural factors contributing to excellence performance in science and mathematics education via native language, such as those reported in international studies like TIMMS.
- A more comprehensive study to trace the historical development of science teaching and learning via Chinese language among the Chinese in the mainland China and those who have immigrated to other parts of the world, to identify the

enabling and inhibiting factors for science learning, causes for LCI for people of this ethnic origin, the values/belief system or attitudes towards nature of science or scientific investigations and the development of Chinese vocabularies for science learning.

- An experimental study to compare the learning of science among the control group of Chinese educated students who were brought up in families influenced by Chinese culture and the experimental group of non-Chinese educated students who were isolated or brought up in the families totally not influenced by Chinese dialects or culture. The *proactive* and *retroactive inhibition* arisen during the process of learning among these groups can then be studied in a more thorough manner.

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Philippines

Understanding Incommensurability and Indeterminacy in Filipino Culture, Language and Scientific Concepts

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Abstract: Basic knowledge of science is shared by many societies and most knowledge in recent times has come to various parts of the world apparently from the west. It is also assumed that when teachers teach science they bring worldviews in the science classrooms to promote understanding that science can be interpreted and made meaningful in various ways by different individuals, including the science teachers themselves. With the universality of science, explaining scientific concepts and terms from western origin using the mother language, is commonly practiced among non western countries. The "how" of this process is the subject of much discussion in relativism of culture and language as teachers are also cultural beings. As a consequence of acquiring *knowledge about knowledge* some cultural translation has become a *misfit* on the assumption that *a lingua franca or common language exist that makes it possible to incorporate scientific concepts, methods and assumptions from each conceptual origin and discipline.* The purpose of this article is to understand issues of language and scientific concepts incommensurability from language-laden cognition particularly in Filipino language. The discussions uses the trans-disciplinary induction (TDI) method to explain the logical outcome of incommensurability or indeterminacy in the translation of scientific concepts from western origin. This approach is used as an insight to understand incommensurability between language and scientific concept in the translation of the Filipino language in teaching science.

Introduction

The worldview theory in science education has generally proceeded from an assumption that there exist distinguishable entities called "science" and "indigenous knowledge'' at all times and in every place in the world. This assumption has been the philosophical ground point of typologies that describe the relationship between science and religious thought (e.g, Haught, 1995; Barbour, 1997). Haught characterizes the relation of four variables: conflict, contrast, contact and confirmation. The conflict position defines science and religion to be inherently incompatible. This position is defended on two grounds: methods (scientific theories are falsifiable; religious theories are not) and epistemology (science is non revelational while religion is revelational).

From, this standpoint, language philosopher Ludwig Wittgenstein, cited by Philipps,(1996).

> *An individual does not get picture of the world by satisfying himself of its correctness, but as a result of the inherited background against which he distinguishes between true and false.* (Wittgenteins, 1953. p.)

The interplay of culture and language in science education is an area of growing interest in research. The research and findings of Cole and his associates on culture, cognition and education probably have the greatest influence on educational anthropology (Cole et al 1971; Cole and Scribler 1974; Gay and Cole, 1967) as cited by Husen and Postlethwaite (1993). In their extensive work among the Kpelle of Liberia, Cole and associates explored ways in which culture influences how students performed in standardized intelligence test, and how they think. In their findings, test results were not indicative of "true intelligence" partly because of cultural influences on test situations. Another was a distinction between cognitive processes which are universal (i.e., ability to remember, form concepts, memorize, think abstractly and reason logically) and the cognitive skills which are culture specific.

An ongoing debate in science education concerns the effects of students' worldviews on their learning of science (Dzarma & Osborne, 1999). World views refer to the fundamental beliefs about the world, and may refer to the totality of experiences and explanations that have been built prior to an individual's experience with school science (Cobern, 1996). Epistemological beliefs about the nature of knowledge are related to learning strategies (Hogan, 2000). Many educators postulate that students with high levels of commitment to traditional beliefs and values are likely to perform worse than those with lower commitment (Jegede, 1990, 1998; Cobern & Aikenhead, 1998).

Students' performance in science hypothesized that those from traditional non-western societies may perform poorly in sciences because their indigenous worldviews and cultural values are in conflict with the western science (Jegede, 1997; Jegede and Okebukola, 1989; Ogunniyi, Jegede, Ogawa, Yandila, and Oladele, 1995). Ogunniyi, Jegede, Ogawa, Yandila, and Oladele(1995) investigated the nature of worldview presuppositions in five non-western contexts and concludes although there are minor variations from one culture to another, the worldview presuppositions held by subjects are essentially identical. They attribute this commonality to the monistic worldview of non western societies. According to Jegede cited by Koul (2003);

> The non western learner uses the arthropomorphic worldview to build enabling structures to understand nature including school science, which is different from how western learner would build his own structure of the mechanistic worldview" (Jegede, 1998, n.p.)

Science Education in Philippine Society

In the early decade of the 1950's, scientists were concerned with the state of science education in the schools. The concern was expressed concurrently in the theme of the 1958 Annual Conference of the *Philippine Association for the Advancement of Science* which focused on the training of science teachers and the teaching of science. The inadequacies and weaknesses of science teaching were recognized as those relating to undertrained teachers, the inadequate science curriculum in schools and colleges, and the minimum time allotted to science. Furthermore, the conference also called attention to the importance of the growth of science consciousness in the general population and the need to remedy the shortage of scientist in the country (Maybury, 1975).

In the Philippines, there is a high degree of bi- and multilingualism, particularly in the Manila area but degrees of language competence are not known. Before the Americans established English as the language of education in 1900, Spanish had been the colonial lingua franca, although it was learned by only among the elite Filipinos.

Since 1900, English increased its hold and is estimated that by the time of the Second World War about one quarter of the population had competence in using English.

Today, Filipinos exceeding 56 million speak more than 70 dialects. Tagalog and Cebuano are each natively spoken by about a quarter of the population, Ilocana and Hiligaynon are more than ten percent each. Bicol and Waray are spoken by about 5 percent of the population. Altogether there are three dozen mother-tongues with more than 30,000 speakers. The major internal rivalry has been between Tagalog (the language of the capital) and Cebuano. With the independence in (1946) Spanish, English and Pilipino (termed as Tagalog) became official, although Spanish continued to dominate in many spheres having many place in the broadcast media, however the biggest newspapers are in English.

From 1957, the Philippine government made the teaching of science compulsory in all elementary and secondary schools. Hubler, (1964) noted some salient characteristics of science education in the country. Foremost was the language problem. A minimum of three languages had to be learned by the children in places where the local dialect is Tagalog, which is the base national language, Filipino. These languages are Filipino, English and Spanish. For the rest of the country for non-Tagalog speaking areas, children have to learn four languages, including their local dialect, Filipino, English, and Spanish. For those homes whose spoken language spoken is not the local dialect, the children have to cope up with the dialect.

In the early 70's the use of English and Filipino as media was implemented for specific subjects from the elementary level to the university and the use of Arabic in Muslim areas. English was the medium for instruction in science and mathematics. Efforts were made to upgrade the 3 Rs (reading, writing, and arithmetic).

In 1994, the study of Ibe cited issues related to cultural heritage and technology on the perceived dichotomy between science and technology and the traditional culture. These two however, cannot be treated differently since both are interrelated. While science is a body of specified procedures or set of observations or discourse it is a way of thinking and a cultural phenomenon that encompasses activities as learning abstractions such as learning the language of mathematics, learning to use, manipulate and direct nature, learning to inquire and to be doubtful instead of accepting authority unquestioningly, as well as learning to accept a true proposition only if the proposition has not been falsified. These also include attitudes that impel the individual or society to act in the above mentioned directions.

Thus, it seems that technological learning becomes successful only when cultural learning has provided new attitudes and approaches or if it has succeed in introducing a new world view. This was realized that the new learning should permeate in all subsystems in the Filipino society, not just the science subsystem. Without such cultural learning, attempts to enhance technical learning to include understanding and appreciation of science as part of culture was an enormous and significant task that concerns all citizens not just the teachers, the educators and scientists.

Using Trans-Disciplinary Induction To Understand Indeterminacy and Incommensurability

To understand issues of incommensurability, this paper explains the definition of "Trans, discipline /specialties, and incommensurability or indeterminacy". Trans is derived from a Latin word "*across, further beyond and over"*. In biochemistry and biology it means *transfer* of *e.g. genes across species, i.e transducers, trans-genetics*. In this discussion,

trans is used in the sense of *transferring knowledge about knowledge across discipline or overview of knowledge about knowledge to explain incommensurability. "Trans"* is also contrasted with "*inter"* as in Jean Piaget's (1973) *Main Trends in Inter-disciplinary Research*. "*Inter"* is a prefix derived from Latin meaning "*between, among, amid, in between disciplines on sharing observations and understanding"*. Piaget's analysis was rooted in the positivist tradition of Logical Empiricism which is defined in linguistic terms as the common rules of grammar, vocabulary and syntax used by different disciplines to prove their findings which excludes, the non linguistic, non codified forms of knowledge such as the aesthetic experience which disappears in the process of the analysis (Chartrand, 2005).

The term "*discipline"* is derived from old French, meaning "*instruction of disciples"*. *Discipline is what is practiced and a doctrine concerning what is taught and thought*, *i.e* body system of principles or tenets. How it is taught is pedagogy, *i.e* the art or science of teaching (OEC, 2004). What differentiates "*modern disciplines"* from "*medieval discipline"* is the emphasis on additions rather than interpretation of existing knowledge. This change has become embodied in "research-based university" which appeared first in University of Berlin in 1809 spreading to United States and beyond. Emphasis on new knowledge led to the progressive fission of the natural and engineering sciences into ever increasing array of sub-disciplines and specialties (Kuhn, 1996). Each has each own's differentiated theory, language, practices, instruments, research agenda and talent. Each tends to bifurcate into theoretical and practical branches. Furthermore the taxonomic structure of many discipline in the humanities and social science is culturally determined.

From Chartrand (2005), the process of splitting off (Latin meaning of science) is an example of division and specialization of knowledge in action. This has benefits on the detailed examination of a phenomenon but also on the costs of increasing incommensurability i.e. *the "inability to communicate knowledge to the uninitiated"*. In some ways, like in the manner of speaking, what is gained in depth and detail is lost in breadth of vision.

In logic, "*induction"* refers to reasoning from specific to general in contrasts to deduction which refers to reasoning from general to specific. The word *"induction"* is derived from French meaning, *"among other things, the action or initiating in, the knowledge of something or evidence developed from other discipline of thought*". This methods however, relies on language which can articulate some, but not all forms of tacit knowledge (Polanyi, 1962). Noting, that induction has also difficulties in treating phenomena such as the aesthetic experience, works of technological intelligence (Aldrich, 1969); instrumental realism (Idhe, 1991) and instrumental epistemology' (Baird, 2004).

In using Trans-disciplinary Induction (TDI), TDI builds strongest evidence and argument gathered from philosophers arguments. However, their contributions are generally subject to dispute and debate internally to its respective disciplines. Evidence must be gathered using one's own external reading (Loasby, 1967). From Kuhn's (1996) view even the choice to solve normal science puzzle, is influenced by a natural scientist's culture, experience and language, even the natural and engineering sciences are also value-laden.

Beyond incommensurability there is indeterminacy of knowledge. *Incommensurable is having no common measure except unity*. Thus, while we have the knowledge about arts, sciences and society there is no common measure on others than the exact word of knowledge itself. The incommensurability of knowledge has been identified explicitly by scholars in wide range of discipline including: Daniel Bell (Sociology); Walter Lippman (Journalism);Naom Chomsky (Linguistics); Carl Jung and Magorah Maruyama

(Psychology); Thomas Kuhn and Michael Polanyi (History, Philosophy, Sociology of Science).

In Kuhn's (1970b) work on *The Structure of Scientific Revolution*, he observed that specialization and puzzle solving within a paradigm of normal science generates knowledge that is *incommensurable* even to neighboring specialties and by extension to other knowledge, domains disciplines and society as a whole. Semi- permeable barriers or paradigms separate specialties and fostering specialization has generated dramatic growth in our knowledge and control of the physical world. The very success of the natural sciences, has been argued on the axiom: good paradigms make good neighbors (Fuller 2000).

Polanyi (1962) writes explicitly of incommensurability between what is subsequently become known as "codified and tacit knowledge" in technical performance. He also implied that knowledge obtained through belief defined by articles of faith and that derived from science are incommensurate (Polanyi, 1952); and scientific and technological knowledge are incommensurate reflecting the profound distinction between science and technology which is the study of nature and on the other the study of human activities and its products.

If one uses the trans-disciplinary induction, this can arguably use biological imperative to know the immeasurability and incommensurability of knowledge. It cannot however, escape the meta- methodological dilemma of language. Excepting tacit and tooled knowledge, knowledge finds expression through a human language, each of which including mathematics (Boulding, 1955) is subject to inherent conceptual limitations. To know knowledge from western origin, one begins studying the word, its origin and meaning *i.e* etymology. A *"word or discourse*" is part of a language that is in turn the foundation of the traditional *"nation" or people e.g. Filipino language or people.* In addition to the word or vocabularies, language differ in their grammar including syntax *i.e.* ordering of words and when reduced in writing, they differ in alphabet (phonetic) and or script (ideographic) Kanji, Mandarin, Roman. The spoken and written language is a defining feature of culture which is primary but not exclusive means which human knowledge is expressed and exchanged between individuals and across disciplines. Sometimes however, as with the logical positivist, language is treated as synonymous with knowledge which leads to other forms being ignored. This has been called "semantic ascent" (Baird, 2004). Nonetheless "language–in-use is the all" embracing sort of activity.

Incommensurability also pertains to those cases where representation aims to approximate an object (whether the object of representation aims to approximate an object of representation is three dimensional space, inner consciousness, social reality or any dimension of the real). The notion of linguistic meaning is multifaceted and subject to endless controversy, but most thinkers agree that *"meaning, denotation (i.e reference) and truth"* are key semantic notions.

The most widely discussed form of semantic relativism in recent decades is the doctrine of incommensurability championed by Thomas Kuhn (*e.g* 1976b). Paul Feyeraband (e.g 1962) citing to support Whorf and several other science philosophers in the 1960s. Although their views become more nuanced over the years, their early proposal on the terms (e.g. mass, gene, temperature, electron) of scientific paradigm (Kuhn, 1970) or high level background theories (Feyeraband, 1962) draw their meanings from their location or overall role in the paradigm or theory.

When a scientific paradigm or theory changes substantially, as happens during a scientific revolution, scientists change their minds about the truth values on many of the most important thoughts or beliefs involving these terms (e.g. the mass of an object is the same relative to all inertial frames") and surprisingly new claims employing such terms

maybe added to the picture. Hence, the argument continues, the roles of such changes, together with the meaning of the theory "semantic or the meaning of holism", which that "*the view or the meaning of linguistic phrases and sentences is determined by their place in the overall web of beliefs or sentences that comprise a theory or, at the limit, an entire worldview"*.

If the thesis of the meaning "holism" is right, then substantially different theories cannot contain words or phrases that have the same meanings. This adds incommensurability, and in such case the claims of competing theorist cannot be compared, because even when they seem to be using the same word *e.g.* Newton and Einstein use the word *"mass"*, it means different things and past each other. And so, from the standpoint of Kuhn and Feyeraband their claims and beliefs and theories become incommensurable.

To formulate realistic account on beliefs or mental content is also possible, so that the meaning or content of a belief is determined by its place in a large web of beliefs, and to develop an account of incommensurability and relativism in terms of concepts rather than words. Most of the issues that concern are similar in either case. however, and much of what follows applies to the content of concepts and beliefs as to the meanings of words and sentences. Sometimes relativism is simply equated *with the view that there are or could be completely incommensurable frameworks*. This extreme view, which rarely defended in any detail has little to recommend, because it simply dismisses many interesting versions of relativism. Still incommensurability support these varieties of descriptive relativism, since disciplines with quite different outlooks would have different frameworks of concepts, standards and beliefs.

The Philosophy, Language and Cultural Translation

From earliest times, man's culture has always felt the need to construct a frame of reference that would established an order to explain the how's and why's of daily existence, that could help him find meaning of the world around him. Today, cultural societies are generally conscious of how language describes the way people do things and perceived reality around them. By adopting naïve presuppositions, problems are encountered in translations across languages bringing fundamental differences between civilizations.

Translation has been an essential cultural ingredient of every society to establish equivalences between two languages. The process of translation would seem at first an unlikely tool; the purported impossibility of finding the equivalent words then itself serves as a sign of different radical words. How are claims of different worlds constructed from differences of words? As argued by Davidson (1974) against the conceptual relativism of Quine (1960); Whorf (1954); Thomas Khun ((1970); and Paul Feyerabend (1962).

Thus, Kuhn (2000) for example explains the purported incommensurability, of scientific paradigms through analogies to differing linguistic taxonomies. Feyerabend explains incommensurability between "cosmologies" through analogies in forms of art. Whorf (1956) explains differing linguistic systems through examples in science. Quine (1960) explains differing conceptual schemes through analogies in physics. Furthermore, Martzloff and Gernet explain incommensurability of thought through analogies to linguistic differences via Benveniste's *copula*, 1960 cited by(Hart, 1999).

These various notions of incommensurability as interpreted, can precisely deal with artistic and cultural phenomena that proclaims a realist attachment to the world. Incommensurability can pertain to cases where representations is a three dimensional

space, of the inner consciousness, social reality or any dimension of the real. The incommensurability can involved modes of representation that cannot *contain* or *exhaust* an object just as any given scientific concept is always short of catching corresponding natural phenomenon because the object is always shaped by the concept in use and because there are other, incompatible ways of conceptualizing objects. Hence, something from the description is always left out of its representation, to which existence of other modes of conceptualization from previous scientific explanations attest.

Incommensurability is a characteristics not only of the realist mode itself but it also applies to the relations between different modes of representation. Yet when disengaged from the *word* determined from the past theory, the incommensurability involved using linguistic mechanism, it is still possible to reconstruct the conditions under which terms of the theory become meaningful. Scientific scholars have been borrowing from the conceptual coffers Aristotle, Descartes, John Locke and others to understand the directions on these conceptual schemas.

Using Trans-induction In Filipino Language Incommensurability or Indeterminacy on Scientific Worldviews

The concept of worldview, however comes not from the sciences but from anthropology and philosophy, which inclines one to think that "one could make a even a broader concept from the original than what would typically be considered a conceptual example". From a cultural perspective, all of the persons thoughts forms a vast conceptual idea that is considered a worldview (Cohern, 1991; Kearney, 1984). Hence, one can suspect that the ideas about science constituting a scientific worldview must be interpreted and articulated under the influence of other aspects of a worldview. Thus, acquiring an abstract notion of scientific worldview in reference to an actual person is probably less helpful than acquiring about how the person has enacted a scientific worldview.

In the context of the western Wview, the chosen three most intensely researched examples of incommensurability from Filipino translation represents the best episode on the subject as patterned from the analysis done by Kawasaki (2002). Applying historical research to philosophical problems similar to what Pierre Bourdieu calls *fieldwork in philosophy*, the discussion will outline the claims of incommensurability or indeterminacy between these scientific concepts and the cultural Filipino language translation.

The cultural meaning of 'Observe"

In the philosophical framework of incommensurabilty, the western Wview of the term "*observe"* means that the observer uses senses to construct the world around him and detaches itself from the phenomena. The principle of observation means, finding the best way to examine the phenomenon based on than speculations rather than deciding what the conclusion must be on what is already known. It means gathering empirical evidence because empirical means observable. In Filipino, the term "observe" is further translated as "*masid"* where the observer is part of it, fixed by nature. As the observer provides a distinctive kind of effects, its aspect yields results that can be arbitrary from scientific ability and scientific sensibility shaping the concept subjectively. In context, "masid" is being able to affirm what others have affirmed. However, when the phenomenon cannot be directly observed the questions arises "whether the signs are really accurate indicators of the phenomenon".

From the following assertions, a wide variety of arguments on the relation of language to thought have been presented in historical studies. According to Benveniste's central argument;

> *that language and thought are coextensive, interdependent and indispensable to each other.* Linguistic form is not the condition for transmissibility *"but first of all the condition for the realization of thought'.('*Beneviste, 1966. Problems in General Linguistics. Originally published as Probemes de linguistique generale.)

In science, only the terms in the observation language that are derived from deductions during observations are to be considered reliable scientific terms, because only these could have fixed and have reliable meaning. For Kuhn, a world view is successful when it is so internalized from childhood that it goes unquestioned. However, some translated terms are poorly defined allowing distortions from what it actually mean based on logical positivism on two assumptions:

1. there can be infallible observations and
2. deductions from the observations are sufficient to capture all reliable and necessary ways to describe science.

The Filipino's Conception of 'Nature'

An example of language incommensurability in Filipino arising from this attempt, following a justification departing from Wviews is the meaning of word *nature.* In Filipino, "*nature"* is translated as "*likas"* which means quality, a state beyond creation or an inherent value. The word *likas* closely refers to the character of God more powerful than the minds of people can conquer. From this cultural language characteristics *likas*, cannot be acquired but created by a divine character beyond human ways. The very essence of *likas* is associated or controlled by a super being. It is a mysterious expression of an omnipotent God who is responsible for natures existence. In the Wview, "*nature"* is recognized as a typical characteristic of any living entity that supports life. The concept of nature describes reality of concrete categories or systems supporting life. It also consist of systematic progression of organisms as laws of nature are predictable. Hence, examining this two contrasting views describes the incommensurability on the concept of "nature".

According to Peter Berger and Thomas Luckmann (1966), realism is defined as a social construct of reality. Reality in some measure is a type of artistic representation, which emerges from the idea that art can represent reality without distorting it in any significant manner and different phases of the realist, project are fix on ways to deal with this representational aim. The realist mode is hence distinguishable from modes of artistic expression. The realist does not aim at mimetism and its history is the result of an incommensurability between realist and non realist modes of representation.

Cultural views on 'Practice'

Furthermore, to analyze the Wscience concept on "*practice"* in science it literally means "the ways of evolving things, from developed skills upon which is the basis of a scientific theory". Practice is an exercise upon which the development of scientific theories are based. " *Gawin",* is the Filipino word for "*practice"* resulting to a belief or desire resulting from daily actions. "gawin" is associated to a product or a common sense action " *in a much like sense"*, "for *one to be able to do so much",* or "*to understand the beliefs*

of a believer". It further means, "what working is", "what being polite is". Perhaps the idea on the Filipino term for *practice* is a synthesis of indigenous conception of historical methods developed from western historical discipline. Practice as a discipline in science has already experienced great developments from scientists all over the world through the years. These developments could have become the figurative tools or instruments of historians in coining the term *practice* in Filipino language.

These specific examples cited as Filipino translations of incompatibility could have resulted from the differences in the conceptual meaning during the translation. This point of reference according to Quine (1960) is the inscrutability of reference on the basis of indeterminacy of translation. Departing from the observers behavior, one have no possibility of knowing the respect to which the terms of a language are true. Davidson (1974) accepted the inscrutability of reference and the indeterminacy of translation realizing the existence of some problems concerning the derivations of the terms.

The Language Culture and Scientific Concepts Incompatibilty

To explain these Filipino language incommensurability, the author uses Putnam's (1981) arguments cited by (Alarcon, 2004). The indeterminacy are perhaps reflections of the following consequences limiting students understanding of world's science:

The Religious Approach To Science "What is science and what is not?"

The meanings and beliefs of very different cultures are also sometimes said to be incommensurable. For example, it might be argued that words like "miracles" (beyond scientific explanation, our concept of the supernatural power) derives its meanings from its relationships to words or concepts (e.g. power, spiritual realm), God(e.g. makes breakthrough an expression over what humans cant do) and process (e.g. beyond the experimentation and impossibility in principle by scientific explanations).

When the meanings, concepts and beliefs and traditions and practices of another culture are substantially different from our own, it follows that none of their words (complex phrases) line up well enough with the meaning of our word or concept, or as having any beliefs about.

Taking Wittgensten (1953) views on religious beliefs, the Filipino worldview best illustrates the Christian worldview on "life in the world is created by a super being responsible for the preparation of things beyond human endeavors. Beliefs rejects the Greek concept of cycles that retained the idea of history as a decaying process. Human history is linear, not progressing to a perfect state; rather history is seen as an inspiring struggle in which forces of evil continue to sow chaos and disintegration in the world. In brief, Filipinos still embrace the medieval philosophy concerned on the nature of God, the application of Aristotle's logic and thought to every area of life. This expresses the Christian worldview if God exists at all, he is surely the most important feature of the universe therefore worthy to be studied, probing the existence of God through logic. Towards the end, society is viewed as an organic whole, a kind of divinely directed moral organism which has the ability to control the world and each person had a part to play, (Rifkin, 1980).

Haught, (1995) science and religion deals with totally different levels of reality, science deals with the physical reality, while religion deals with the metaphysical or the trancendental.

Cultural Views and Science-Mode of Representation

Another factor that has limited students understanding of scientific thought is the belief that meanings of scientific terms can be captured by neat bundles of necessary and sufficient conditions which oftentimes are products of traditional or cultural views arising from inadequate knowledge of its reality. Many concepts such as "genetic structure'' lacks necessary and sufficient characteristics in the Filipino representation and often times the behavior of its expression is associated with cultural beliefs. All categories including technical concepts as *DNA, RNA* appears to have graded structure, that some items are even more difficult to be represented culturally.

In all the representations from Wscience, the term is difficult to operationally define the concept of biomolecules for a better example. The concept of inheritance, in genetics often receives one or another operational definition, but comparing operations requires that the investigators have the same underlying notion of what controls the DNA in the nucleus of the cells; yet there is no satisfactory definition of terms. Similarly, in Physics, Nersessian claims that there is no set of necessary and sufficient conditions for defining the concept of electromagnetic field, despite its long history of investigation in physics. Insisting that concepts be formal and rigid may make investigations of those concepts easier, but basing an analysis on inappropriate elements, no matter how accessible they are still bound to be misleading.

The Linguistic Relativism

Language along with culture is the most frequently discussed variable, the most that commonly influence thoughts. This was generalized by Nelson Goodman (1978) that symbol systems including computer languages, conventions for diagrams even styles of painting influence perceptions and thoughts. Language affects how one experiences and thinks about the world and the influences can vary in magnitude, so linguistic relativity can differ in the strength of its influence.

Following Kitcher's (1988) analysis of Kuhn's (1982) discussion of incommensurability, the possibility of incommensurability between two paradigms, language and thoughts is due to adherent use on these two paradigms that are mutually translatable. There are multiple methods for determining the referent terms, including definitions, descriptions, theory relative similarity, etc. Within paradigm, each has a way of determining the referent, which determines the same item. Incommensurability between theories occurs when the items determined by one theory do not exist in the other, or so when some of the uses of a term determines one item and some determine another item in the other story. However Whorf presents that when languages are similar there is likelihood of dramatic cognitive differences. But languages that differ markedly from English and other western European languages as SAE "standard average European often lead their speakers to have different worldviews. Thus,

> *"we are thus introduced to a new principle of relativity, which holds that all observers are not lead by the same physical evidence to the same picture of the universe, unless their linguistic background are similar, or can in some way calibrated ... the relativity of all conceptual systems, ours included, and their dependence upon language stand revealed*" (Whorf, 1956, p.214f, italics added)

Cultural Transmission

Culture is perhaps the most central theoretical concept in anthropology, which is very important in social science and science as well. The nature and role of culture are matters of controversy, with many general characteristics. Culture is socially transmitted from one generations to the next. This includes ideals about how one should live, customs, mores, taken for granted common knowledge, systems of production and exchange, ways of coping with illness, disease and death, legal institutions, religion, rituals, rites of passage, myths, taboos, technologies, social hierarchies and status, sexual practices, accepted ways of displaying emotions, marriage, kinship structures, power hierarchies, sports games, art, architecture and language. There are always differences in outlooks and beliefs within the same culture, especially in large and heterogeneous ones. The cultural relativism reflects the persons culture strongly influencing modes of perception and thought. Many anthropologist particularly in the earlier parts of the twentieth century view culture as a force that was nearly limited in its power to shape human beings.

According to Ruth Benedict (1934) cited by Lewis (2001):

> No man ever looks at the world with pristine eyes. He sees it edited by a definite set of customs and institutions and ways of thinking. Even in his philosophical probes he cannot go behind these stereotypes …. The life history of the individual is first and foremost an accommodation to the patterns and standards traditionally handed down in his community. From the moment of his birth the customs into which he is born shape his experience and behavior. By the time he can talk, he is little creature of his culture and by the time he is grown and able to take part in its activities, its habits are his habits, its belief s and his beliefs, its impossibilities his impossibilities. Every child that is born into his group will share them with him and no child born into one on the opposite side of the globe can ever achieve the thousand part (1934, pp.3-4).

Amorphous debates over pre-logical and preliterate modes of thought that were ones popular have now given way to more detailed and precise work in cross cultural psychology and cognitive anthropology (Berry, et al 1996, Cole, 1996; and D Andrade, 1995) cited by (Saiz, 2005). The event to which cultural forces shape modes of thought is still not fully understood however have similar modest cognitive differences between cultures, nothing remotely as dramatic as the claims made on literature about cultural relativism.

Kuhn (1970b) proposed the approach of viewing science as a perceptual problem with the Gestalt tradition. Gestalt perception consist of organizing perceptual information into a coherent sensible whole. The particular Gestalt that was reached was affected by the context, expectations, and prior information of the perceiver. Kuhn argued forcibly that similar psychological were essential to science and scientific practice depended not only on specific facts but also on psychological features of the scientist culture.

Conclusion

The Importance of Philosophy of Science in Science Education For Teachers

Admittedly, in the local Philippine society there is not much that can be derived from the history of local developments on scientific knowledge which had been based on the dominant Western culture that has engulfed the country since 1600 century.

Over the last few decades, the philosophy of science has taken a naturalistic turn. Instead of emphasizing a rational prescriptive approach to science, most science have focused on how scientist actually conduct their work. When scientific process are examined, it becomes clear that the actual scientific practice of discovery had little to do with the formal processes prescribed by positivist that *" the scientist makes statements and hypothesis or systems of these and tests them against observation and experiments".*

Cultural terms became necessary to develop conceptual tools that would allow students to think about the process of doing science, allow them to understand how scientist combine their human cognitive abilities with the conceptual resources available. Students as members of scientific cultural community need to understand, practice and communicate new scientific representations from their knowledge of science.

In relation to this issue, educators and scientists have become concerned about the differences between the nature of science as described by modern philosophies of science and the way it is perceived by teachers, the science curriculum and the science textbooks. Many teachers would define science simply as a body of knowledge and a way of thinking and doing things, more specifically as a way of looking at problems and finding answers to those problems. Elkana (1992) cited by Hernandez (1996) outlines some points of discussion a way to correct incommensurability between scientific concepts and language which have an effect on the philosophy of teaching science leading to incommensurability.

Through a deeper understanding on the nature of science and its processes teachers should emphasize that science is much more than just four or five steps of the scientific method and teach science as an exciting, interesting complex enterprise involving scientific discoveries, people, institutions, and society. This is the very argument on the need to teach history and philosophy of science to students.

Another reason to teach the philosophy of science, is to promote better science learning; for whoever knows only one view or one form of view, does not believe that another ever understood in its place or that another will succeed. Such a person neither doubts or tests. It is also claimed that ontogeny recapitulates phylogeny- there is a parallelism between the progress made in the logical and rational organization of knowledge and the corresponding formative psychological processes.

The philosophy of science should be central to the practices of science education to justify what and how to teach it. Such knowledge is dependent upon the knowledge of epistemology of science, because school science projects an image of science called empiricist, inductivist, widely disseminated among school population. Teacher needs this knowledge to combat myths in science teaching.

It is also important to develop existing awareness of a wide range of issues to epistemological considerations in science education, *e.g.* integration of science, functions of experiments and practical work, discovery methods, Piaget's epistemology, curriculum analyses. The relationship between pedagogy and epistemology is becoming increasingly important in the face of growing interdependence of the learners to the environment.

Awareness of science and its method of inquiry may actually influence the way a teacher teaches. An important function of teacher educators is to change attitudes, and

teaching styles. This cannot be achieved by exhortation. Reasons must be given and these are more persuasive if they can be shown to have underpinnings from the epistemology of the subject.

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Language Culture Incommensurability in Science in the Philippine Education Context

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Introduction

The view that thought might be shaped --- or even determined --- by language has been around for centuries. Many post-modernists hold a version of the Sapir-Whorf Hypothesis in a stronger form than either Edward Sapir or Benjamin Lee Whorf would have done. Its strongest form is the claim that linguistic structures condition thought patterns and determine one's perception of the world.

Incommensurability, according to Lloyd Spencer (1998), is a term derived from the mathematical theory which refers to two qualities or magnitudes which have no common measure. The notion has been loosely translated or transferred into the widespread debates about the role of language. Two languages are incommensurable if their structures make exact translation between them difficult or impossible. Literally, incommensurability means "no common language". To Kuhn, incommensurability means something more limited: that "there is no language, neutral or otherwise, into which both theories, conceived of as sets of sentences, can be translated without residue or loss."

The Sapir-Whorf Hypothesis, as it is known today, can be broken down into two basic principles: linguistic determinism and linguistic relativity. Linguistic determinism refers to the ideas that the language one uses determines, to some extent, the way one views, and thinks about, the world around him. The concept has generally been divided into two separate groups – Strong Determinism and Weak Determinism. Strong Determinism is the extreme version of the theory, stating that language actually determines thought and that language and thought are identical. Weak Determinism, however, holds that thought is merely affected or influenced by one's language, whatever that language may be. It is this version of Determinism that this paper is anchored on.

The Science Curriculum in the Philippines

Science education in the Philippines dates back to the period covering the pre-Spanish era to post-World War II, when emphasis was focused on Science with Health orientation (Ibe and Ogena, 1998). In the Philippines, at present, Science is taught from the elementary level (6 years) to the secondary level (4 years) with English as the medium of instruction. In the elementary level, emphasis is on Science and Health. The secondary level, on the other hand, includes Earth Science, Biology, Chemistry and Physics. Topics on Environmental Science are integrated in all Science subjects at the secondary level.

Great emphasis is given to the teaching of Science and Mathematics in the Philippines today, with the conviction that economic and technological progress will only be possible through a scientifically and mathematically literate citizenry. At present, instructional focus is on three subjects: Mathematics, Science and English. It is significant

to note that all textbooks in Science and Mathematics are in English. It is likewise common knowledge that Mathematics is a tool in learning Science.

One possible reason why Science is given emphasis in the Philippine curriculum is to lead the Filipinos away from the realm of superstitions and unfounded traditional beliefs, consequently moving them to develop a scientific mind. Despite overwhelming technological advancement, however, many Filipinos, even those dwelling in urban communities, continue to believe in the preternatural, convinced that fairies and earth-bound spirits exist and influence, even disturb, human beings. They believe that bad spirits could cause people harm once hurt or disturbed. Thus, one's ailment is conveniently attributed to preternatural causes and, instead of seeing a physician, the patient runs to the folk healer or "babaylan" whose rituals are believed to be able to placate and appease the aggrieved spirit.

Science education in the Philippines is greatly influenced by the Americans. From the early 50s to the present, Science and Mathematics classes in the country use mostly American books.

The Philosophical Outlook of the Cultural Communities

The Philippines was under Spanish rule for more than three hundred years. The colonizers unposed the Roman Catholic religion on the natives. It is, thus, not surprising that, at present, 85% of the Filipinos are Roman Catholics. The Spaniards have, indeed, greatly influenced Filipino beliefs, traditions and mores. Many Filipinos are deeply religious, believe in miracles, and have a strong devotion to saints. In the Philippines, one finds various statues of saints and an array of sacramentals in Catholic churches, an overt manifestation of the Filipinos' religious piety which, oftentimes, borders fanaticism.

Spanish records and surviving indigenous traditions leave little doubt that the early Filipinos believed in a Supreme Being known by its various names depending on the different regions of the archipelago. Among these names were: *Bathala, Diwata, Kabunian, Mansilatan, Makaptan, Laon, Lumauig, Mamarsua, etc.*

The natives of the islands associated God with *langit* or heaven and the sky, connecting Him with the Sun, the heir of the sky. Theirs was a concept of God as a pantheistic spirit or body. Moreover, they had a concept of different bodies or souls of varied existential levels. The highest of these souls was perceived to be part of a collective and all-pervasive universal body.

In ancient times, Filipinos made offerings to certain trees where benevolent deities and ancestral spirits were supposed to be dwelling. Other trees, however, were thought to house malevolent spirits. Thus, extreme care was taken to avoid disturbing these trees.

The forces of nature were often addressed with much respect and reverence. The Ilokanos for instance, used the term *Apo* for this purpose: *Apo Tudo* (Lord Rain), *Apo Init* (Lord Sun), *Apo Pagay* (Lord Palay). *Apo* was also used to address the Supreme God. Examples: *Apo Guino* (Lord God) among the Kapampangans and *Apo Langit* (Lord Heaven) among the Ilokanos.

The ancient Filipinos saw life as a struggle. The forces of nature were believed to make life difficult and temptations to do evil were an overwhelming presence. People must struggle to conquer sickness and poverty. At the same time, they must lead good lives to avoid going to the dark and lonely world of the heathens after death. They also believed that they were constantly guided and aided by the spirits of their ancestors, said to assist God and to be in charge of different activities and phenomena in life.

Cosmological Outlook of the Cultural Communities

Early Filipinos viewed the cosmos as consisting of multiple heavens or universes, each without form or boundary. In a way, these were similar to the modern concepts of dimensions. These heavens were not stacked one upon the other, although a concept of differently stacked heavens also prevailed. The heavens or universes existed in different dimensions and, thus, were not thought of as occupying the same space. Although infinite, they did not come into contact with one another.

Creation myths abound in the Philippines, one of the better known being the Ilocano's **Deimurge** as discussed by Calip **Mamarsua,** or **Namarsua,** is the creator who, by thought and action, produced **Parsua** which refers to humankind or to the created universe as a whole. Man is considered to be a microcosm of the vast universe.

The Supreme God was associated with the heavens, while the Son of Heaven was symbolized by the Sun. This cosmic pair was apparently very important among the early Filipinos. The union of the two celestial bodies at the New Moon and their opposition at the Full Moon were considered to be of great spiritual significance. It was from this that the Filipinos derived their concepts of cosmic balance.

Omens were constantly observed and considered, especially before long journeys or the start of important enterprises. The stars were consulted to determine or foretell courses of events. Among certain Igorot tribes, certain stars would have to come in line with the Moon before they could decide to perform important activities like hunting expeditions, battles, sacrifices, etc. The different phases of the moon also served as very important guide for the early Filipinos in their performance of various tasks and endeavors, especially those which concern family life, health and economy. Building a house, transfer to a new home, start of a new business, investment of money, wedding, baptism of a child and start of harvest are best done at the approach of the full moon to ensure happiness, harmony, prosperity, success, and good harvest. The full moon is, at its brightest, was a good omen, its round shape symbolizing money or wealth.

Language Culture Incommensurability in Science in the Philippines

English is the medium of instruction in the teaching of Science in Philippine classrooms at all levels. Science books and materials are all in English. In effect, Science educators find it very difficult to translate and explain English scientific terms in the local dialects like Hiligaynon, Cebuano or even Filipino, the national language of the country. It must be noted that the Philippines is composed of 13 regions and, generally, each region has its own dialect.

Common scientific terms, like **nature, observe** and **practice,** when translated in the native dialect or in Filipino, would connote different meanings and confuse the students more than help them understand the terms and the concepts they convey.

For example, the word **nature** in English means "the things around us, which were created by God." In others words, everything not made by man. In the Hiligaynon dialect, **nature** is *sa palibot* or *kinaiya* or *kinaugali;* in the national language it is *kalikasan. Sa palibot* refers to the things in the surroundings while *kinaiya* and *kinaugali* points out the inherent qualities or traits of a being. On the other hand, *kalikasan* shares the same meaning as "nature".

One other case is the word **observe,** a common term used in Science books and classes. In Hiligaynon, it is *magpanilag* or *maghimutad* while in Filipino, it is *pagmasdan*

or *suriin.* The direct translation of the word **observe** confuses the students because it has various equivalent terms in the local or the national dialect, specially because, in Science, the connotation of the word is "to examine and study scientifically using one's senses". In the local and national languages, it simply means "to look very closely at an object."

A typical case of how one's thought is affected or influenced by one's language is the use of the term **mass** in Physics where the unit used is kilogram, gram and slug. In the native dialect, kilogram refers to weight or *kabug-aton.* It is very common for people to ask "What is your weight?" or "Ano ka kabug-at?" in the local dialect. One buys a kilo of meat or a kilo of rice in the market, indicating that ***bug-at*** refers to **weight.** However, in Science classes, the students are told that kilogram is a unit of mass and weight is measured in Newton, dyne, and pound. These terms are, of course, alien to the students and have no equivalent terms in the local dialect.

In effect, students often make mistakes when asked to solve a problem where mass and weight are involved. This occurs mostly when solving for work done on an object. When a student is asked, "How much work is done on one sack of rice of 50 kilograms when it is lifted to a height of 100 meters?", he replies with "5,000 kg-meter", certainly a wrong answer because work is the product of force times distance (F x D). Thus, 50 kilograms, which is the unit of mass, should be multiplied with 10m/sec, the acceleration of gravity, in order to get the weight of 500 Newton. This weight or force should be multiplied with the height of 100 meters to come up with the correct answer of 50,000 Newton – meter.

Another example is the word **acceleration** and **deceleration** in Physics. In the local dialect, acceleration is translated as *"kadasigon"* and deceleration is *"kahinayon."* But W-science defines acceleration or deceleration as "a vector quantity which has both magnitude and direction." Hence, even if the speed is constant but there is a change in direction, the object is considered accelerating. This concept is again a source of difficulty for Filipino students in Physics.

In this regard, to help enable the students understand the concept of an accelerating object even if the speed is constant, there is need for a demonstration of an object moving in circular motion. This clearly shows how acceleration occurs when speed is constant but there is a change in direction due to the circular motion.

The concept of **momentum** in Physics also creates a problem among Filipino students because it does not have an equivalent in the local dialect. What the Physics teachers do is show an object which has mass and is made to move. The product of the mass and the velocity is its momentum.

Recommendations to Overcome Language Culture Incommensurability in Science

It is a fact that students' thinking is greatly affected or influenced by the language they use. In the Philippines, this problem is graver because of the presence and use of various local dialects. It is, therefore, imperative that Science teachers be very innovative and creative in presenting science concepts, processes and skills for the students' better understanding. Translating scientific terms from English to the local dialect results Babel-like confusion among the students, especially if the translation is not precise or accurate.

It is thus recommended that, if direct translation is impossible, science concepts be defined operationally and experiments conducted to demonstrate how the concepts work. With the use of computers and softwares, these concepts could be simulated for the students' benefits.

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Teaching Scientific Concepts Using Hiligaynon and Cebuano Dialects In Philippines: Towards A Language-Culture Incommensurability

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Introduction

Incommensurability in the Philosophy of Science

Philosophies of science are ultimately concerned with the question of how we should carry out scientific research given our understanding of the nature of science. Originally, philosophers of science sought to explain how science should be conducted successfully by scientists such as *e.g.* Einstein. More recently the philosophy of science has moved on to showcase how most scientists actually work given the social and practical circumstances of their work.

We all have questions about the world around us, " What is real and what is fiction?" What do we know and how do we know it? How can we find out more about the world? Philosophers analyze these questions intensively, with all the practical and reliable answers are provided a the seemingly endless scientific questions, perhaps incommensurability is an inevitable factor that hinders the wholistic understanding and comprehension of all these scientific concepts which are irreconcilable.

Ruth Ronen (1997) claimed in her paper that Incommensurability occurs in science where two theories lack a common measure, a standard reference, or an external criterion that could have served as grounds for comparison. Yet, although incommensurability appears to stem from the absence of a world beyond theory, there would be no place for the notion of incommensurability in our epistemology when theories are not given realistic interpretations.

In other words, in order to assume that theories are incommensurable, we have to assume that each theory works as a conceptual net through which the world is seen differently. Assuming that a theory employing the term 'star' sees an object through this term; each theory can give the term 'star' a different realistic interpretation, that is, identify the term with another celestial body. Incommensurable theories, while each sees the star differently, all represent stars. Without realism towards theories and towards the entities they assumed, theories would have been straightforwardly intertranslatable and commensurable.

Ronen further emphasized that incommensurability between theories means that while a given theory assumes it can 'grasp' an object, the theory is also caught in the impossibility of really grasping it in any exhaustive way. In a similar sense, in assuming that art can realistically represent, both the artist and critic view in an object through the mode of representation chosen while being caught in the impossibility of grasping the object in any exhaustive way.

In art, as in science, each school and even each particular artwork, is fixated on a specific object, and is fixated on representing it in a specific way. Yet the object of representation is always also the object that escapes representation and we need the conviction of a representing agent (scientist or artist) to believe in the presence, a tentative and elusive one though, of the object through representation.

The term 'incommensurability' has gained consideration together with the view that all languages are incommensurable one with another. The most precise formulation of this view presented by Willard van Orville Quine in his book ***Word and Object*** as cited by Spencer (1998), as part of a more general scepticism about the very idea of meaning. Quine dramatized what he termed 'the indeterminacy of translation'. This is not the same as the platitude that there are shades of meaning which might be lost in the process of translation. On the contrary, it implies that the very notion of shades of meaning which are uncaptured is pointless. Each language posits a different set of objects, maps the world in a different way. Even the objects of the physical sciences (and of ordinary common sense) are 'cultural posits'. Quine's 'ontological relativism' is expressed in such formulations as: 'in point of epistemological footing the physical objects and the gods [of myth and legend] differ only in degree and not in kind'.

Incommensurability is also associated with Thomas Kuhn's philosophy of science, although it can be shown to figure in other versions and formulations in the work of earlier philosophers. According to Kuhn, incommensurability by definition undermines any claim to the growth of human knowledge or any claim that scientific propositions will gradually converge unto truth. The reason for this lack of validation procedure has to do with the fact that paradigms of science are discontinuous, each constructing a world differently. Scientific lexicons, even though repeatable from one paradigm to the next, are also incompatible because each scientific lexicon relates terms to phenomena in a different manner. After a scientific revolution, names and terms are often guarded intact, but the objects and phenomena assembled under them have changed (compare the sun, moon and stars as items in the scientific lexicon before and after Copernicus.)

Just like seeing the image represented in Figure 1. How can one see an Eskimo entering his igloo when he did not even know that such particular group of people exist? One would see an Indian and interpret it most likely as the head of a chieftain when he is of an Indo-Malay aborigine. But the other way around is the perception of the one living in temperate and polar regions.

Fig. 1

When individuals sees this figure, unless well-educated and a wide reader individual could hardly view the figure above as an Eskimo. Although the Philippine curriculum is trying to be global and highly competitive, it is unavoidable that because of language and cultural barrier concepts presented in schools and textbooks are not understood holistically. Philippines, being a multi racial country with almost 300 dialects spoken

through out the archipelago, incommensurability occur particularly in the teaching of scientific concepts.

Philippine Basic Education

Basic education in the Philippines is composed of six years of elementary and four years of secondary education or a total of ten years, one of the shortest in the world. Within ten years, Filipino youth complete basic education at the age of 16 or 17 years. Students' proceed to institutions of higher learning, to obtain a degree or a certificate from a post-secondary vocational/technical institution, or enter the world of work. Basic education in the Philippines is free at both levels but compulsory at the elementary level only.

In the Philippine education system, the central office forms policy and sets standards that are implemented by the regional and division offices. Supervision of schools, therefore, is the function of the regional and sub-regional offices.

Science And Technology Education In The Philippines

Curriculum development at the basic education level is the responsibility of the Bureau of Elementary and Secondary Education, Curriculum Development Divisions at the Central Office. The bureau defines the learning competencies for the different subject areas, conceptualize the structure of the curriculum and formulate national curricular policies. These functions are exercised in consultation with other agencies and sectors of society.

The subject offerings, credit points and time allotments for the different subject areas are determined at the national level. In this sense, there exists in the Philippines a national curriculum. Schools, however, are given the option to make modifications/adaptations on the curriculum (e.g., content, sequence and teaching strategies) to ensure that the curriculum responds to local concerns.

The programme at the basic education level sets out to meet the needs of the students and society as a whole. The curriculum is designed to ensure that the student upon graduation from a secondary school will be able to learn more independently, acquire academic excellence, and develop the capability to cope with new knowledge and technology.

On the other hand, elementary schools prepare students to cope with the challenges of secondary education. Science is one of the subject areas in the elementary and secondary education curricula. Science and health is offered forty minutes daily from grade I at the elementary level. In the secondary level, it is offered as science and technology and is taken eighty minutes daily. Since there is no streaming, or grouping of students according to their intellectual capacity, at the higher levels of secondary school, there are science schools or schools with science and technology-oriented classes/ sections.

Aims And Objectives

The government recognizes the importance of developing its science and technology capability as a means of addressing the concerns of industrialization and globalization. The education sector, along with other government agencies, is tasked to contribute to the achievement of the national development goals. As such, the Department of Education

(DepED) has focused its efforts towards programmes and projects aimed at improving English, Science, and Mathematics education in basic education.

The objectives of elementary and secondary school science is that at the end of grade VI, the child is expected to apply scientific knowledge and skills in identifying and solving problems pertaining to health and sanitation; nutrition; food production, preparation and storage; environment and the conservation of its resources; and evolving better ways and means of doing things. (Bureau of Elementary Education, 1998)

The Secondary Science Education Programme aims to develop understanding of concepts and key principles of science, science processes, skills and desirable values to make the students scientifically literate, productive and effective citizens (Bureau of Secondary Education, 1998). These objectives are contained in the preface for the learning competencies.

Curriculum Plan

The approach to curriculum design in the country is content-topic-based and competency-based. The school children are expected to master a list of competencies at the end of each grade/year level and at the end of elementary/secondary schooling. The Bureaus of Elementary and Secondary Education develop, publish, and issue to the field the learning competencies.

The content in science and health is organized in increasing complexity from grade I to grade VI, in categories on people, animals, plants (and environment), matter (mixture and solutions, physical/chemical change, materials at home), energy, Earth, and the sun (the solar system, beyond the solar system).

In secondary school, science includes general science (first year), biology (secondary year), chemistry (third year) and physics (fourth year). To provide for additional competencies for fast learners, enrichment is added in some topics (BSE, 1998).

Teaching methods and learning activities

The curriculum plan does not include teaching methods for the teachers. It is in the teacher's manuals or guides that higher-level content and suggestions for teaching and assessing instruction are included. Being able to plan and use the appropriate teaching-learning activities are challenges to the creativity of the teachers.

Learning materials such as textbooks, supplementary materials and science equipment are provided. Learning activities are not confined to the classrooms.

A curriculum develops through a dynamic process and is subject to periodic evaluation, which produces recommendations for modifications or even major changes. We are living more and more in a world which we filter all kinds of information and news far and near places and we act on the basis of the filtering process everyday. Our world is increasingly constituted by information, usually from our Western counterparts and is one which has to take many forward-oriented decisions. Contemporary Filipino learners are confronted with an explosion of knowledge, and they have to take stock of a daily barrage of data and commentaries from far and near.

Filipino learners have to filter information critically, seek credible sources of knowledge, and use data and facts creatively so that they can survive, overcome poverty,

raise their personal and national self-esteem, and realize gracious life in a risky new world. This is a world that has become borderless to information, commodities, financial investments, crime, terrorism, and ecological problems that sometimes even our own national identity is forgotten because of too much concern and accommodation of western knowledge, concept, ideas and even interpretation of things through their own perspective.

To actualize a gracious life in our changing world, Filipino learners need an educational system that empowers them for lifelong learning or enables them to be competent in learning how to learn anywhere even when they are left to themselves. However due to language barrier and translation of terms in teaching scientific concepts since English is just a third language (1st-Hiligaynon or Cebuano, 2nd – Filipino), learning distortion especially in scientific concepts usually occurs.

This is the challenge posed by a rapidly changing world but it is nearly impossible today for anybody without functional literacy which includes essential skills like linguistic fluency and scientific-numerical competence. Thus, we should ask: are our learners attaining functional literacy? How sure are we that the concepts thought not incommensurable with our students own understanding?

The ideal Filipino learner in our rapidly changing world is one who is empowered for lifelong learning. He is an active maker of meaning, and can learn whatever he needs to know in any new context. Such an empowered learner is competent in learning how to learn and has the skills so that he becomes a self-developed person who is makabayan (patriotic), makatao (mindful of humanity), makakalikasan (respectful of nature), and makaDiyos (godly). This is the vision of Philippine basic education both formal and non formal.

Philosophical & Cosmological Outlook

This vision is evident in Manansala's (2005) presentation that the Filipinos cosmological belief almost all possessed ideas of an active creation by God, the Demiurge. Most Filipinos are Christians and they have high regard to God the Almighty, the Creator. They also respect nature and some indigenous tribes even worship them and treat them like gods. Generally speaking, the active creator was not necessarily the Supreme God, for both Bathala and Diwata, the creator gods of different parts of the Philippines, are in some cases said to have a "father." In other belief systems, the Supreme God acts as creator in a different manifestation than the normal one. For example, among some Bagobo tribes, the Supreme God, Kerenen, becomes Megbeveya as the creator, sustainer and ruler of the universe, and Midlimbag, as creator of the earth.

Possibly, this highest form of God had some of the naturalistic characteristics found in the beliefs of other peoples and among the ancient faith of Aten in Egypt. There are creation myths in different parts of the Philippines that point to an interaction of opposites between very natural elements that results in the primal creation. Loarca mentioned one belief in which the universe is without beginning, but the creation of life is initiated by the "marriage" of the sea breeze, which would represent the masculine principle, and the land breeze, the feminine.

Another similar myth tells how creation comes about by the somewhat antagonistic interaction between the sea, which here represents the feminine, and the heavens, the masculine. Such concepts are very similar to the idea of yin and yang in China, the ultimate manifestation of which is the interaction of heaven and earth resulting in creation. In fact, the myth of the primal sea below heaven pre existing at the point of creation is a common one not only in the Philippines, but among many Malay-Polynesian peoples.

However, unlike some myths in Polynesia and on the island of Nias, there are few ideas of evolutionary developments in the creation of the earth and its life. In most Philippine myths, these are created quite suddenly. One theme has the earth created by God dropping a stone from heaven into the primal sea! Interestingly enough, the physical universe in this myth is symbolized by the sea, while the spirit world is the sky. In fact, an idea of our earth as a stone floating in the sea is remarkably accurate in a symbolic sense!

Duality

However, before this duality there was a nonpolar creation or evolution brought about by the thought and will of the Supreme principle, or a manifestation of the same. Such ideas can be found from the North to the South, from the Ilokanos to the Bagobos. This is probably more of a transformation than creation. The Supreme God, in the highest form, is beyond our comprehension and our knowledge of space, time and language. However, in another manifestation possibly brought on by something similar to an evolutionary process (we really are unable to understand), God becomes the active Creator. The universe and the other life forms are willed into existence by this manifestation of the Supreme.

Sometimes, this form of God only creates the other divine beings, with the physical world being created by yet another manifestation. When the creator appears as the "son" of the Ultimate Deity, there is a blurry line between the two suggesting unity, and a situation not much different from that of the creator being only a manifestation of the Supreme God.

Although God in the highest manifestation was seen as distant, the people or individual could call upon even this form in times of distress. Only for regular mundane activities and problems was this considered inappropriate. There indeed was some logic in the Philippine idea that the highest God was not to be approached except in near emergencies or on a periodic basis for worship. The Filipino could easily surmise that God did not appear before us, or speak directly to us, but instead stayed "beyond the beyond." The Filipino seems to have respected this distance that God had chosen. Instead, the Filipino conceived that God had helper spirits, often know as anito or diwata, who were assigned to assist humans and others in regular mundane matters. These might be the Philippine equivalent of the "angel" in Abrahamic religions.

The answer here lies in the idea that Filipinos shared with most other animist peoples. The Filipino did witness evidence of these diwata and anitos in the natural phenomena and the other events occurring in their lives. The movement of the wind, the revolution of the luminaries, planets and stars, the seasonal rains, etc., etc., were all seen to be motivated by spiritual forces assigned to this task. Like all animists, the Filipino saw all objects and phenomena has inhabited or governed by spirits.

The Filipino was firmly convinced in the immortality of human and all other spirits, and saw evidence that these continued after death. One may question their judgement in the light of modern Western ideas, but even today surveys have shown that even most Westerners believe in life after death. The cyclical nature of events must have convinced the Filipino, as it did others, that certain spirits governed certain phenomena, and thus prevented chaos from prevailing in the cosmos. For it was the order of these cycles, particularly the seasons and the cycle of agriculture, that allowed life to go on in an orderly fashion.

Respect for Nature

Manansala also pointed out that in the light of such beliefs it is not surprising that the ancient Filipino had a great respect for nature. The relevant spirits were first addressed before practically any undertaking, or even many ordinary activities. So great was the ancient Filipino's respect for nature that they addressed other creatures and even inanimate objects with terms of respect, for example, the Ilokanos even addressed the rice plant as Apo Pagay "Lord Rice Plant." In taking from nature, the Filipino thus was *borrowing* in a cycle that was mutually beneficial and structured according to a cosmic balance. Humans themselves were seen as composed of the elements; either three or four of the following: earth, water, fire and wind. Sometimes, other elements also come into the picture. At death, a person's body returns to the elements, and thus nourishes the earth by means of these elements. We do not only take but also give. To abuse the balance of nature was one of the great sins.

Christian beliefs of Filipinos were reinforced after the arrival of Magellan in 1521. The Spanish conquest introduced Christianity through Roman Catholicism. Aside from the spread of Christianity, hundreds of loanwords, and a Western outlook on the world also co exist with the indigenous animistic beliefs. After Spanish colonization, the United states introduced a widespread elementary and high school education program, whereby own-languages and English literacy became the norms.

All Filipino indigenous language would be incompatible with English. Some are directly translated and borrowed from English and Spanish language itself to avoid incommensurability and misconception of terms and concepts.

With the introduction of English as another language of Filipinos to be learned more incommensurability developed. Among dialects in the archipelago, there exist already incommensurability how much more with the influx of a western language and terminologies?

Language-culture incommensurability in science in Hiligaynon and Cebuano Languages

Susana Narotzky (2000) emphasized that communication is the process of making unique experience into common experience, and it is, above all, the claim to live. For what we basically say, in any kind of communication is: 'I am living in this way because this is my experience'... Since our way of seeing things is literally our way of living, the process of communication is in fact the process of community: the sharing of common meanings, and thence common activities and purposes; the offering, reception and comparison of new meanings leading to the tensions and achievements of growth and change.

Definitely, we can not separate the experience of an individual in the community where he ultimately belongs. And what is experienced by a person is shared by everybody in the community and expressed through language common in a specific place. The interpretation of a particular indigenous group is different from a certain group because of the varied interpretations, beliefs, customs and traditions. Their world view may be different from the world view even of the same race in the same country because their communication is entirely different from each other. Take note, that the process of communication is the process of community.

Let us try to examine the two common Visayan language, Hiligaynon and Cebuano. Hiligaynon or Ilonggo is an Austronesian language spoken in Western Visayas in the Philippines. Hiligaynon is concentrated in the provinces of Iloilo and Negros Occidental.

It is also spoken in the other provinces of the Panay Island group, such as Capiz, Antique, Aklan and Guimaras. There are approximately 7,000,000 people in and outside the Philippines who are native speakers of Hiligaynon, and an additional 4,000,000 who are capable of speaking it with a substantial degree of proficiency. *Ilonggo* is also the name of the culture associated with the people speaking Hiligaynon. It is a member of the Visayan language family.

Hiligaynon is the fourth largest Philippine language. It has many dialects. For example the alternate language name Ilonggo originally reffered only to the dialect of Iloilo City. Almost every town, especially those along language borders with Cebuano, Kinaray-a and Aklanon, has some variation in lexicon and intonation. Those dialects that have notable differences include Capiznon (which is spoken in Capiz province on central eastern Panay) has also several lexical idiosyncracies and Kawayan (which is spoken in the town of Cauayan South of Bacolod and City on Negros) has phonological idiosyncracies wherein an [l] between vowels is often replaced by [y], e.g. Hil *ulan,* Kaw *uyan* '*rain*'.

On the other hand, the Cebuano Language categorized as Malayo-Polynesian language is spoken primarily on the island province of Cebu. It is the primary language used in Cebu City and throughout the Cebu province. It is actually a variation of the Visayan (Bisaya) Language. The Cebu province is central to the Visayan region. Cebuano is the primary language of the Visayan region.

Cebuano, also known as Sugbuanon, is an Austronesian language spoken in the Philippines by about 18,000,000 people and is a subgroup or member of Bisaya, Visayan and Binisayâ. The name came from the Philippine island of Cebu, with the Spanish suffix -ano meaning native, of a place, added at the end. Cebuano is a member of the Visayan language family.

Cebuano is spoken natively by the inhabitants of Cebu, Bohol, Negros Oriental and the people in western Leyte province and northern Mindanao. It is also spoken in a few towns and islands in Samar. The language is the second-most spoken language in the Philippines after Tagalog.

Cebuano is a language with Verb Subject Object sentence order. It uses prepositions rather than postpositions. Nouns come after adjectives, but before genitives or relative phrases.

Cebuano has sixteen consonants: p, t, k,? (the glottal stop), b, d, g, m, n, ng, s, h, w, l, r and y. There are three vowels: i, a, and u/o. The vowels **u** and **o** are allophones, with **u** always being used when it is the beginning of a syllable, and **o** always used when it ends a syllable. Accent is also a distinguisher of words, so that *dápit* means "to invite", while *dapít* means "place".

Cebuano has long borrowed words from Spanish, such as *krus* [*cruz*] (cross) and *brilyante* [*brillante*] (brilliant). It has several hundred loan words from English as well, which are altered to conform to the limited phonemic inventory of Cebuano: *brislit* (bracelet), *hayskul* (high school), *syapin* (shopping), *dikstrus* (dextrose), *sipir* (zipper), *bigsyat* (big shot), or *prayd tsikin* (fried chicken).

Both Hiligaynon and Cebuano are Visayan languages. The name Visayan was the Spanish rendition of the adjective *bisaya* referring to a person or item from the central Philippine islands and the verb *binisaya* meaning to speak Bisayan. It applies to 36 different speech varieties, the most well-known of which include Cebuano, Hiligaynon, Waray and Aklanon. Together, these groups represent over 40 percent of the Philippine population, almost double that of any other language in the archipelago. The word probably derives from a dialect variant of a Malay loan *bicara* 'to speak', based on the propensity of many Filipinos to name their language.

Example, Waray 'there is none', *Ja un* 'over there', the Kinaray-a say '*bisara'* 'to mention'*,* Aklanon has *bisala* 'to utter' and *bilisad un* 'saying maxim', while the Cebuano, banton, Surigao, Kawayan, Odiongan and Romblon dialects use *bisaya* 'to say, speak'. Thus, it is evident that even in simple similar terms across the nearby regions incommensurability in the terms exists.

Most particular in Cebuano and Tagalog (the 1st largest language in the Philippines) language. For instance, discussing Kingdom Animalia in Biology and you give example like *langgam,* which is in Tagalog, ant, while *langgam* in Cebuano is a bird. Another is *pating. Pating* in Cebuano term is a dove but the same word *pating* in Tagalog means a shark. Birds and Fishes are incompatible with each other hence, *pating* in Tagalog and *pating* in Cebuano is incommensurate with one another. All the while you thought that students are getting your example and all of sudden they ask they ask how can a bird (*pating* in Cebuano) swim (*pating* in Tagalog)?

Ken Kawasaki (2000) had been emphasizing that Science educators must be led to take student's as well as science educators, language-laden cognition into consideration. Definitely, foreign language education does not aim to replace pupil's first by the foreign language concerned. Hence, the notion "language-laden cognition" makes it possible to conduct science education without student's losing their language-culture identity.

Although we can not avoid the conflict between two worldviews, the western and the local worldview, the conflict should be settled to refrain students from cultural identity crisis.

Taking for instance the topic on mass (*kabug-aton*) and weight (bug-at / *timbang*). It is a world view that mass is the amount of matter in an object expressed in kilogram while weight is the pull of gravity to an object expressed in Newton.

In physics, mass is amount of matter that a body contains, and a measure of the inertial property of that body, that is, of its resistance to change of motion. Mass is different from weight, which is a measure of the attraction of the earth for a given mass. Inertial mass and gravitational mass are identical. Weight, although proportional to mass, varies with the position of a given mass relative to the earth; thus, equal masses at the same location in a gravitational field will have equal weights. A mass in interstellar space may have nearly zero weight. A fundamental principle of classical physics is the law of conservation of mass, which states that matter cannot be created or destroyed. This law holds true in chemical reactions but is modified in cases where atoms disintegrate and matter is converted to energy or energy is converted to matter.

Incommensurability occurs in these two terms because if students will be asked of their weight, they will automatically answer you in kilogram. They won't agree that it is the mass that they are actually referring to. In filling up bio-data or resume or even personal profiles, individuals need to fill up specific data like height and weight. And weight here does not refer to the pull of gravity of course but the weight in kilograms supposed to be the mass.

A mother buying at the supermarket would ask a local vendor in Hiligaynon or Ilonggo language the cost of a beef saying, "*tagpila ang kilo*?", "how much per kilo?" And the vendor weighing it gives you the weight again in kilograms. Mass has never been used in local and ordinary conversations. Inside the classroom, confusion and argument will take place because science educators usually teach particular terms while students associate it with terms based on their own linguistic background.

With the aid of awareness of the recognizing aspect, science educators should be clear with what pupils think. Educators need to ask these questions: Are both the teacher and the students arriving at the same destination? Or both are going on the opposite direction?

Another incommensurable term in biology is when teaching taxonomy. Kingdom, being the highest category in classification system, literally means *sinakpan* and *ginharian* in Cebuano and Hiligaynon respectively. Having a kingdom connotes power, authority and sovereignty. The Philippines being a hierarchical nation even before the Spanish colonization, Kingdoms are owned by Sultans particularly in Mindanao.

According to Quevedo (2005) Bangsamoro (from bangsa, nation) in Mindanao, (the second largest Island in the Philippines) is a term that goes back to the early 14th century when Islam was introduced to the animist Indo-Malayan inhabitants of Mindanao and Sulu through the missionary activities of Arab traders and teachers or Sufis who came along the trade route. Although such missionary efforts were apparently without a systematic plan, a Muslim community was already flourishing in Sulu toward the end of the 14th century. By the middle of the 15th century a Muslim sultanate was already established in Sulu. Islamic missionary efforts in the 15th and 16th century also succeeded in establishing sultanates or kingdoms in the Lanao and Cotabato areas. In the last years of the 15th century, Islam had already reached out to the north, where Muslim Rajahs such as Rajah Sulaiman Mahmud, Rajah Matanda and Rajah Lakandula ruled over what is known as Manila today.

Islamic groups spoke different languages and demonstrated great differences in customs and traditions. What brought the communities together into a distinct and identifiable social group was the common religious bond of Islam that totally governed their social structures, their relationships, their values and their way of life. Such unity in diversity was already long before the term "Filipinos" came to describe the indios colonized by the Spaniards in the second half of the 16th century.

The Muslim communities shared a common political and governmental structure based on the sultanates or kingdoms of rajahs, with their own defined territories. They also shared a common history of resistance in Spain and later against the Americans. In the 16th to the 18th centuries, the Muslim communities might not have had a sense of distinct political nationhood (as understood today), but they consider themselves quite distinct from everyone else by their adherence to Islam. By the 19th century, Muslim leaders and thinkers were convinced that the Moros constituted one nation, a belief that they impressed on the American colonizing government always with passion and often with violence.

One may argue investing the Moro social and political community with the name "nation" but one cannot escape the fact that during the first century of Spanish colonization, the Islamic peoples of Mindanao, Visayas and Luzon, had a socio-cultural and political identity distinct and separate from the Spaniards and the Christian indios. Thus, even without pressing the argument of nationhood, there was by the end of the 16th century among the Islamic communities a developed a sense of religious and cultural unity and identity to which one may give at least seminally the name bangsamoro. Such sense of "nation" certainly matured when from the very beginning and for more than 300 years they resisted waves of military campaigns by Spanish military forces and their Christian Indio subordinates and later by American troops. Thus, Muslims in Mindanao consider this land of promise their own kingdom even many Christians like Hiligaynon and Cebuano also thrive in Mindanao.

Students therefore would tend to associate Kingdom into "*ginharian*" or "*sinakpan*" where somebody like a sultan is the leader. Thus, in teaching Kingdoms in taxonomy, they would assume that someone who rules a particular Kingdom is the most powerful. In the West for instance, we adopt the idea that the lion is the King of the Jungle. But students in the Philippines particularly in Mindanao did not even caught a glimpse of

what a lion is unless seen in the zoo, books, or pictures. Lions are not natural inhabitants of our country.

Queries and doubts form in their minds. Students are confused by learning cultural values embedded in the Western language and they always come up with linguistic incommensurability. Thus, they would ask if lion is the king in the Kingdom Animalia, them who is the King in the Kingdom Plantae? A flower? Should it not be a queen? What about in Kingdom Monera or Kingdom Protista?

Local science educators are not aware that they lack awareness of linguistic diversity. As long as they finish the competencies outlined by the Central Office, then science teaching is done and enough. Owing to this is the attitude toward this topic on population or *populasyon* (direct translation from English). Population in Hiligaynon and Cebuano terms is "kadamo sang tao" or "kadaghan sa tawo". Philippines being one of the most populated country in the world, Filipinos always associate the term population to people.

The Philippine Commission on Population (POPCOM) even said that the next five years would be crucial in achieving the Medium Term Development Plan (MTDP) target as more than half (50.7 percent) of Filipino couples are still not practicing family planning. Last year's Family Planning Survey estimated the country's contraceptive prevalence rate at 49.3 percent just a little bit higher than the results of the 2003 National Demographic and Health Survey (48.9 percent).

The government is committed to meeting the goal of the MTDP as the president has her support to reducing the PGR to 1.9 percent by 2010 in her many public pronouncements. An estimated 1.8 million children are being born in the Philippines every year. With four babies delivered every minute, the country is the 12th most populous nation in the world. Its population growth rate is one of the highest in the Southeast Asian region.

Half of theses births, according to the 2004 FPS, are considered risky because they were conceived by women who are either too young or too old to get pregnant, who had too many children, and who had frequent pregnancies. Filipino mothers bear an average of 3.5 children to as high as 9 mostly by those considered as the poorest of the poor.

Population, in biology however, is a group of interbreeding organisms in a specific region—for example, the members of a fish species in a lake. A given population is usually isolated to some degree from others of its species, whether geographically or in terms of behavioral or anatomical differences. Population however becomes incommensurate among Filipino students because normally they would link it to the total number of human inhabitants of a specified area, such as a city, country, or continent, at a given time.

Concepts such as these needs to be translated in the light of our cultural understanding to make it commensurate with the world and not vice versa. Science teaching should be converted in a more specific, precise and equivalent word locally to be fully understood. It has to be clear to students' mind that any species or organism for that matter can form a population to avoid language culture incommensurability where terms like population, species and organism has no exact translation in the Hiligaynon or Cebuano languages.

As Kawasaki has been stressing, the cultural premises formulate the way to discover "what ought to exist", which in turn determines what is to be discovered. An anecdotal example for that in a science classroom is the term "egg".

Egg, "*itlog*" in Hiligaynon and Cebuano terms is always associated with male genital particularly the testes. Local notion of *itlog* is for men. *Itlog* is incommensurate in Science classes when a teacher discusses that egg is for women and not for men. Students would always think that men have eggs perhaps because of its shape where the testes

assume its shape at the same time. Filipinos are fond of eating eggs. Most eaten by children are those of the domestic hen, but duck eggs and the eggs of other birds are also commonly used as food. Reptile and insect eggs have also been a traditional food source of many Filipinos in the rural areas. But general worldview would tell us that eggs (*itlog*) or ova are found only in women not in men. In biology, an egg or ovum is in female reproductive body of multicellular animals.

Another classic example is the term heart. "Dughan", "tagipusuon" or "kasing-kasing" in indigenous language would again be incompatible with English scientifically. Heart, being part of the circulatory system has nothing to do with our emotions. Emotion, is a term frequently and familiarly used as synonymous with feeling *balatyagon* or *gibati* in Hiligaynon and Cebuano. It signifies a reaction involving certain physiological changes, such as an accelerated or retarded pulse rate, the diminished or increased activities of certain glands, or a change in body temperature, which stimulate the individual, or some component part of his or her body, to further activity. The three primary reactions of this type are anger, fear, and love.

Filipinos are emotional people. They are known for being warm, loving, affectionate, romantic and passionate race. They always express themselves with all feelings and emotion. As the adage goes, wholeheartedly. An emotion like love for instance is usually connected by Filipinos with the heart.

According to Leavitt as cited by Michie(2005), Love being an abstract concept in indigenous language are specified in relation to actual objects and relationships. The abstractions do not occur as words, as subjects for discussion, or as explicit considerations in perception. Indeed, the view that teaching science in English to some non-Western group of students does not provide them with equal access to information and would tend to lead to varied interpretation.

Thus, teaching in Filipino science classes and trying to expound it through local dialect like Hiligaynon or Cebuano creates incommensurability. Example, the function of the heart and the brain regulating feelings and emotion all coming from the brain and not from the heart particularly in the limbic system. Explaining to students that the limbic system is a group of brain structures that play a role in emotion, memory, and motivation may sound incomprehensible. The stimulations of the amygdala in the brain can provoke fear, anger, and aggression. The hypothalamus regulates hunger, thirst, sleep, body temperature, sexual drive, and other functions like our emotions.

Hence, all emotions coming and processed by our brain is incommensurate and incompatible with students local cultural experience. Filipinos love with all their heart or *tagipusuon* and *kasing-kasing* not with all their brain or *utok*. Different cultures and races have different degree of expressing themselves.

Spencer(1998) pointed out that Incommensurability is a term taken from mathematetical theory which refers to two qualities or magnitudes which have no common measure. The notion has been loosely translated or transferred into the widespread debates about the role of language. Two languages are incommensurable if their structures make exact translation between them difficult or impossible. So it is impossible for a Filipino to love with all his brain.

Recommendations

It seems therefore that what primarily determines incommensurability is the supposition that there is a nature challenging the explanatory capacity of a theory, that the scientist can posit phenomena that exceed the predictive power of a given theory. This is the most

reasonable way to understand Kuhn's claim that differences between theories are not fictive but real, and that any attempt to retrospectively attribute meaning to terms of an old theory, will only result in "partial seeing". A change of paradigm is a change in the way of seeing, a translocation of a conceptual net through which scientists look out at the world. Against the natural tendency of the scientific spirit to describe a continuous history which guarantees that early theory of the phlogiston is connected to later theories of oxidation, Kuhn shows the failure in attempting to interpret earlier scientific terms in terms of current ones. The way for carrying out these interpretative acts is by necessity blocked by the fact that the later scientific point of view represents a "partial seeing" different from the old one.

In order to circumvent this crisis of incommensurability, as Kawasaki suggested, Filipino Science curriculum could still be taught in English but we have to avoid the pitfall of changing the language-culture identity of our students. Science education should be identified with foreign language Education. Science educators must take into consideration the fact that some Western-science is described as incommensurate with the local Filipino dialects like Hiligaynon and Cebuano. Science educators must be clear of the concepts that they want to get across with the students and the language-laden cognition should be taken into account. Proponents of science education must see to it that the conduct of science education does not lose the student’s language-culture identity. (Kawasaki, 2002).

Conclusions

Definitely linguistic relativity generally occurs in any country with diverse cultural setting. Distinctions encoded in one language are unique to that language alone, and that "there is no limit to the structural diversity of languages". If one imagines the colour spectrum, it is a continuum, each colour gradually blending into the next; there are no sharp boundaries. But we impose boundaries; we talk of red, orange, yellow, green, blue, indigo, and violet. It takes little thought to realise that these discriminations are arbitrary - and indeed in other languages the boundaries are different. In neither Spanish, Italian nor Russian is there a word that corresponds to the English meaning of 'blue', and likewise in Spanish there are two words 'esquina' and 'rincon', meaning an inside and an outside corner, which necessitate the use of more than one word in English to convey the same concept. These examples show that the language we use, whichever it happens to be, divides not only the colour spectrum, but indeed our whole reality, which is a 'kaleidoscopic flux of impressions', into completely arbitrary compartments.

Scientists who accept different paradigms experience the world in different ways; they notice some things the others do not, and vice versa. The world consists of the sum of your experiences. Scientists who accept different paradigms experience different worlds.

Some of this arguments depend on the assumption that to re-conceptualize something, to view it is a different way, is to see a different thing. Thus, as if one scientist sees a planet where another saw a moving star, or that Lavoisier saw oxygen whereas Priestley saw "dephlogisticated air." This is an incommensurability of language and experience.

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Indigenous Knowledge Systems and Development

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Introduction

Indigenous knowledge (IK) is the knowledge that certain groups of people have developed and continue to develop over the years. It is based on the experiences of the people and tested over centuries of use. As such, IK is dynamic and changing. It is adapted to local culture and environment. IK is also known as local knowledge, folk knowledge, people's knowledge, traditional wisdom or traditional science. The term refers to the large body of knowledge and skills (Indigenous Knowledge Systems and Practices, Indigenous Technological Knowledge) that has been developed outside the formal educational system, and that enables communities to survive (de Guchteneire, P., Krukkert, I. & Liebenstein, G; 1999).

The Director General of UNESCO (1987 – 1999), Federico Mayor defines indigenous knowledge or traditional knowledge as follows:

> *The indigenous peoples of the world possess an immense knowledge of their environments, based on centuries of living close to nature. Living in and from the richness and variety of complex ecosystems, they have an understanding of the properties of plants and animals, the functioning of ecosystems and the techniques for using and managing them that is particular and often detailed. In rural communities in developing countries, locally occurring species are relied on for many – sometimes all – foods, medicines, fuel, building materials and other products. Equally, people's knowledge and perceptions of the environment, and their relationships with it, are often elements of cultural identity.*
>
> *(Emery et. al; 1997; p.3-5)*

For indigenous peoples all over the world, their ways of life are defined by their set of local knowledge. Traditional knowledge is the basis for their agriculture, food preparation, health care practices, education, conservation and other practices that sustain their society and environment. This knowledge is preserved and passed on from generation to generation by word of mouth or cultural rituals. Most indigenous people have traditional songs, stories, legends, methods and other practices as means of transmitting specific elements of indigenous knowledge. Sometimes it is preserved in the form of memories, ritual, initiation rites, ceremonies, or dance. It is also preserved in artifacts handed from father to son, or mother to daughter.

Characteristics of Indigenous Knowledge

- IK is generated within communities
- IK is location and culture specific
- IK is the basis for decision making and survival strategies
- IK is not systematically documented
- IK concerns critical issues of human and animal life: primary production, human and animal life, natural resource management
- IK is dynamic and based on innovation, adaptation, and experimentation
- IK is oral and rural in nature

Source: de Guchteneire, P., Krukkert, I. & Liebenstein, G.(eds.) (1999). Best Practices on Indigenous Knowledge

The Importance of Indigenous Knowledge

In an article published in the Philippine Daily Inquirer (2000), Curameng stated that IK enriches learning. He found that students could understand concepts and ideas more easily when they are integrated with community practices. Kawagley and Barnhart also claim that the depth of indigenous knowledge rooted in the long inhabitation of a particular place offers lessons that can benefit everyone from educator to scientist, as we search for a more satisfying and sustainable way to live on this planet.

For many centuries, indigenous people heavily depended on their environment to meet most of their basic needs. Therefore, they have closely interacted with nature and thereby gained a sound knowledge and understanding about the environment and its underlying ecological processes. For indigenous people, nature is the source of life that nourishes, supports and teaches. It is the core of their culture, the origin of their identity as a people. "Mother Earth" is the home of their ancestors, the provider of their material needs and a legacy that they can pass on to their children and grandchildren. This feeling of affinity carries with it a sense of belongingness to their place. Almost all indigenous people have developed a deep perception and awareness of the interconnectedness of the different forms of life found in nature. To them, the material and spiritual worlds are woven together in one complex web. They know the extent of their lands; they know how the land, water and other resources are to be used without depleting them. They understand too well that to harm the land is to destroy ourselves, since we are part of the same organism.

To the indigenous people "nature" is a pharmacy that offers a variety of treatment for diseases. They have an intimate knowledge of plants that can be used for medicine. Many trees and plants have a place in their medicinal lore. Indigenous societies classify plant and animal species and recognize their special characteristics. Indigenous people have words for plants and insects that have not yet been identified by the world's botanists and entomologists. The Hanunoo people of the Philippines, for example have distinguished 1600 plant species in their forest, 400 more than the scientists working in the same area. Of the estimated 250 000 to 500 000 plant species in the world more than 85% are in environments that are the traditional homes of indigenous people. Nearly 75% of 121 plant-derived prescription drugs used worldwide were discovered following leads from indigenous medicine. Globally, indigenous peoples use thousands of different species of medicinal herbs and plants. Traditional healers in Southeast Asia may employ as many as 6500 plants for drugs (Burger, J.; 1990).

The vast knowledge of indigenous people about medicinal plants is now beginning to be acknowledged by the rest of the world. Non-indigenous people are now realizing the potential of indigenous medicine. Apart from being locally available, and culturally acceptable it is cheaper than imported drugs. Many are now using plants and herbs to cure ailments like cough, arthritis, fever, hypertension, anemia, diabetes and others. Enlightened health-care workers are beginning to reintroduce traditional plant remedies where allopathic drugs have become commonplace. Some scientists now believe that indigenous knowledge may help them discover new cure for deadly diseases like AIDS and cancer.

Industrialize nations today are facing an ecological crisis. Yet, few admit that they could learn from indigenous people's way of managing their resources. Their practices are considered primitive and too crude for the modern societies. However, these traditional ways of life have proved highly durable. Indigenous knowledge of nature has ensured the survival of many people in fragile habitats. The key to this success is sustainability. Indigenous people today use their intimate knowledge of plants, soils, animals, climate and seasons, not to exploit nature but to co-exist alongside with it.

Indigenous and Scientific Knowledge

Indigenous knowledge can best be understood by comparing it with non-indigenous knowledge (scientific knowledge) which most of us are familiar with.

Scientific knowledge is generated by professional scientists through systematic scientific research and experiments conducted in laboratories or experimental farms whereas, indigenous knowledge is generated by local people through their day-today experiences as they face the challenging and extreme conditions in their environment. Local people conduct research under natural conditions in farms or other places where they usually work and earn a living.

Scientific knowledge generated by professional scientists is often documented, standardized and expressed in global terms. Hence, it is universally accepted and understood. On the other hand, indigenous knowledge mostly remains undocumented and embedded in culture in various forms such as practices, customs, traditions, religious and spiritual beliefs, etc. Unlike scientific knowledge, indigenous knowledge is implicit and cannot be understood by outsiders; it is expressed in local terms and not standardized. Indigenous Knowledge is knowledge of subsistence while scientific knowledge is the knowledge of market economies.

Table 1 explicitly illustrates the differences between indigenous and scientific knowledge.

Table 1: Comparison of Indigenous and Scientific Knowledge

Aspects of Knowledge	Indigenous Knowledge	'Scientific' Knowledge
1. Scope	• Sacred and secular together; includes the supernatural • Holistic of integrated - based on whole systems • Stored orally and in cultural practices	• Secular only; excludes the supernatural • Analytical or reductionist - based on sub-sets of the whole • Stored in books and computers
2. Truth Status	Assumed to be the truth • Subjective • Truth found in nature and faith • Explanation based on examples, experience and parables	Assumed to be a best approximation of truth • Truth found from human reasoning • Explanations based on hypotheses, theories and laws
3. Purpose	Long-term wisdom • Practical life and survival • Powerful predictability in local areas (ecological validity) • Weaker in productive principles in distant areas	Short-term prediction • Abstract; to pass examinations • Powerful predictability in natural principles (rational validity) • Weak in local use of knowledge
4. Methods of Teaching and Learning	Lengthy period of acquisition ('slow knowledge') • Learning by living, experiencing and doing • Teaching through example, modelling, ritual and storytelling • Tested in practical life situations	Rapid acquisition ('fast knowledge') • Learning by formal education • Teaching is didactic • Tested artificially in examinations

Source: Rahum Ulluwisheha, Adbul Aziz Kalako & Dyharuni Hj Mohamed Monican (1997) *Indigenous Knowledge and Environmental Education*

Indigenous and Contemporary Ways of Learning

People in subsistence economies depended heavily on their immediate environment to produce most of their daily needs. Therefore, they closely interacted with their local environment and gained a sound knowledge about it and its underlying ecological process. This knowledge is passed down from generation to generation through informal means of traditional education. The youth are gradually introduced into the norms, religious beliefs, moral values as well as collective opinions through the traditional learning process which includes ceremonies, rituals, imitation, recitation and demonstration (Ulluwishewa, R., Kaloko, A. & Mohamed, M.; 1997).

The introduction of modern education by western industrialized countries resulted in the disappearance, homogenization and eradication of indigenous or traditional knowledge. Colonizers imposed a policy of assimilation which was implemented by missionaries and schools they set up in indigenous communities. Through this, most of the indigenous people's way of life – their cultural practices, traditions, arts and languages were virtually obliterated (Ku Kahakalau; 1992). Some elements of their cultures, those that were deemed acceptable to the "moral" standards of the colonizers and ruling elite were integrated into the dominant national culture. Since national cultures are often defined by the westernized elite, Indigenous Peoples' cultures are considered the "other" culture: quaint and backward (Rovillos; 1999).

Indigenous people's responses to assimilation were varied. Some of them, especially the educated elite, gave in to the assimilations project. Take for example the case of the Igorots in the Cordillera, Northern Philippines:

> *The American educational system was imposed so successfully that the people's minds were conquered so thoroughly they cease to call it their own, in truth and honesty. It led to the loss of their cultural identity, so much so that many Igorots have become ashamed of calling themselves by their tribal names.*
>
> *(Angelo & de los Reyes; 1986*)

Yet, the cultural identity of indigenous peoples was never totally lost. Like the "unpacified" masses of *Igorots* many ethnic groups held on to their indigenous way of life (Rovillos; 1999).

From post-colonial period to present, disparities in education persist. Children from indigenous communities continue to have the lowest performance in schools, the highest number of non-numerates and non-readers, and the highest dropout rates. Thus, indigenous people perceive the western educational systems as failures. Since education in schools do not highlight their histories of resistance and their viable indigenous systems are ignored, local people consider western education as a crucial factor to their marginalization. Even so-called alternative programs have failed because they are not based on concrete conditions and aspirations of indigenous people.

Realizing that the present educational system continue to threaten the survival and transmission of traditional knowledge and do not respond to the needs of their children, indigenous people have undertaken initiatives to reaffirm their ethnic identities. A prominent theme that emerges from these initiatives is the revitalization of their indigenous learning systems while they learn new ideas and skills to survive in their rapidly changing environment. Since culture is not static but dynamic, indigenous people also want to learn "modern" science but in the context of their own culture. They want an alternative indigenous education designed in their own terms and according to their own pace. This is to ensure that valuable aspects of their traditional culture will be passed on from generation to generation. Indigenous people all over the world also want to ensure that their children are not alienated from their cultural identity and indifferent from their struggles. Thus, they demand more direct involvement in the structure, process and content of education.

Language is an important tool in the delivery of instruction. The use of language can tell us a great deal about an individual's sense of cultural, social and ethnic identity. In the light of this, indigenous people demand for the right to speak their own language along with the lingua franca (bilingualism) in the practice of indigenous (alternative) education.

The importance of the use of the child's first language cannot be over emphasized. There is ample research showing that students are quicker to learn to read and acquire other academic skills when first taught in their mother tongue. They also learn a second language more quickly than those initially taught to read in an unfamiliar language (UNICEF; 1999). The World Wildlife fund (WWF) Study may yet provide another reason for preserving indigenous languages. Results of the study seem to suggest that when languages die they take with them the knowledge of generations about caring for the land and its plants and animals. Thus, preserving biodiversity may be another reason for Indigenous People's demand of preserving their languages.

Response from International Organizations

The declaration of UN for the year 1995 – 2004 as the International Decade of Indigenous Peoples was an auspicious move to address the needs of indigenous peoples all over the world. It recognizes the role of education in the marginalization of indigenous peoples, and mainstreamed concrete activities to identify the main characteristics of an alternative education as gleaned from the initiatives of indigenous peoples themselves. And in 10 December 2004, UN declared a Second International Decade the goal of which is the further strengthening of international cooperation for the solution of problems faced by Indigenous people in such areas as culture, education, health, human rights, the environment and social and economic development, by means of action-oriented programmes and specific projects, increased technical assistance and relevant standard-setting activities.

Supporting Indigenous Peoples Education: the Philippine Experience

In answer to the UN's declaration of the Decade for Indigenous Peoples, the Department of Education (DepEd) embarked on various programs and activities in cooperation with other government agencies to strengthen indigenous peoples' education and to help in the preservation of indigenous knowledge. The Department has made this endeavor a critical part of its Five-Year Medium Term Public Investment Plan and budget presentation in the Congress and Senate (Quijano, 2004). In addition, DepEd also issued DepEd Order No. 42, s. 2004 re: Permit to Operate Primary Schools for Indigenous Peoples and Cultural Communities which provides among others, flexibility in the registration of Indigenous People schools for mainstreaming in the educational system.

The Third Elementary Education Project (TEEP)

In 1997, DepEd started its Third Elementary Education Project (TEEP) a flagship project that supports programs for Indigenous peoples in its 23 project provinces which includes Benguet, Ifugao and Antique. The project aimed to serve disadvantaged sectors particularly Indigenous Peoples' children who suffer from absenteeism, dropout, poor academic performance, failure and even founded or unfounded prejudice. Concern of these pupils is being addressed through education development programmes that adhere to the following messages: *allow the community to take an active role in identifying what the children should learn; develop a culture-responsive basic education curriculum and culture-responsive teachers and school administrators; and increase the capacity of each Indigenous people child for national/global participation while preserving his/her identity (and be able to take pride in it).*

In response to these demands, concern schools and divisions have undertaken activities in the areas of curriculum and instructional materials development. Among these are: *preparation and collection of indigenous instructional materials on folklores, folk songs riddles, games, proverbs, and artifacts; localization of existing materials, bridging or translating materials into English; enrichment of Learning resource Centres; training/demo-teaching/mentoring on integration and used of indigenized instructional materials; and development of lesson exemplars*.

Provinces covered by the TEEP have implemented various interventions targeting indigenous peoples' children. One such intervention is undertaken in the province of Antique, which successfully decreased dropout rates and reduced non-numerates and

non-readers among Aeta children. A notable culture-responsive curriculum intervention is the pilot testing of curriculum materials for Manobo pupils in Cotabato. Other interventions include an Orientation-workshop on curriculum indigenisation followed by a "writeshop" on indigenous materials in *Ilocano* and *Tinggian* in the province of Abra; preparation of instructional materials with tribal leaders and Lumad teachers in Agusan del Sur; continuing Adopt-A-child through provision of old clothes and school supplies to indigent pupils in Cotabato; and completion of an School Improvement and Innovation Facility (SIIF) project on supplementary indigenous materials in Mountain Province

Alongside its TEEP programme, DepEd commissioned the University of the Philippines to conduct the Study on Culture Responsive Curriculum for Indigenous Peoples (CCIP). This study explored different modalities in indegenising the curriculum for basic education to make it more relevant to the needs of the local communities, especially the Indigenous Peoples. Among the recommendations of the study were the employment of varied and systematic approaches to localization/indiginesation and enriching of the components of the Basic Education curriculum as well as pre- and in-service training of teachers for CCIP. The implementations of these recommendations require the process of: *organization of subject field to make them relevant to the pupil's culture; adoption of content and learning modes, including indigenous learning systems, from the community; and participation of the natives (learners, parents, local specialists, laymen and local leaders) in designing and implementing the curriculum.*

Observations from initial implementation revealed some factors tha have contributed to the successful implementation of these initiatives. One is the commitment and conscious efforts of the implementers to direct or pool resources to serve pupils from cultural communities and the involvement of other stakeholders in implementation. As observed, mutual learning takes place through sharing of experiences and collaboration with relevant institutions such as the National commission for Indigenous Peoples (NCIP), Schools for Indigenous Knowledge and Traditions (SIKAT) and Summer Institute of Linguistics, Teacher Education Institutions and communities.

Indigenisation and Localisation of the Curriculum

In this paper, **Localization** means the operationalisation of the national curriculum within the context of the local culture and **Indigenisation** means the integration of indigenous learning systems as well as the use of local examples, activities, projects, and folklores to illustrate key concepts (CCIP; 2002 as cited by Quijano; 2004).

Alangui (1997) notes that the things any individual needs to learn to function well as a member of the community are learned in the community as well as in schools. For example, the attitudes, skills and values necessary to be a successful member of the Bagnen community (a northern Philippine KanKana-ey community) are derived from within the community.

The Study on Culture-Responsive Curriculum for Indigenous People (CCIP) recommends that the curriculum can be localized or indigenised by: *using indigenous knowledge – local songs, stories, poems, folklores, etc; using local artifacts as teaching aids; incorporating community resources in teaching – visit to scenic spots, inviting local people as resource persons, etc.; putting up a Learning Resource Centre cum museum where local artifacts are displayed; preparing indigenised guides for teachers; discussing local problems and issues; preserving local games, songs and dances through co-curricular activities; using the local language in teaching; and participating in special local celebrations.*

The following undertakings have been carried out by DepEd to implement these guidelines:

Regional lingua franca experiments: Young (2002) cited an experimental programme began by the then DepEd Secretary Gonzalez in 1999/2000. This programme was implemented in grades 1 and 2 and piloted in 15 regions of the country (all regions except the Autonomous Region of Muslim Mindanao). It intends to increase the proficiency of pupils in their use of Filipino and English (the national and international languages of education, respectively) by using the regional franca as a "bridge". The medium of instruction however, was limited to the three major languages of the Philippines – Tagalog-based Filipino in Tagalog speaking areas, Cebuano and *Ilokano*. In places where the mother tongue is not any of the three recommended medium of instruction, the school administrators were given the option to select the language. Thus, in some areas, there are schools that do not use the lingua franca of the community because its language is not identified as one of those to be used as a medium of instruction. Gonzalez (2001) described the result as encouraging. When compared to the control classes, experimental groups showed slightly better achievement, and observations suggested an increased vitality and enthusiasm in the classes. He emphasized that the Regional Lingua Franca (RLF) programme was an attempt to demonstrate that: the child is most comfortable learning … in his home language and begins to conceptualise rather than memorise formulae and codes as he does …. when the language he is using is not familiar. It was anchored on the view that to provide a relevant early school experiences, which will build upon pre-school experiences, requires the use of the mother tongue.

Materials development: An excellent project undertaken in the development of a localized curriculum is the preparation of a series of six health books and teachers guides for elementary grades (1 – 6) of the Bontoc area schools in the Mountain Province of Northern Luzon. Apart from incorporating the vernacular and the official languages of education, the contents of the books also reflect the cultural identity of the pupils. The illustrations reflect reality for the children. For example in a lesson on care for the sick, the child is shown lying on the floor on a coconut palm sleeping mat (p.68). Lessons on nutrition emphasize food in abundance in remote areas in Mountain province (p.88). Likewise, these health lessons are taught using creative learning strategies such as music, drama, role-plays and practical activities to encourage critical involvement of the pupils. In a lesson on community health, the children are encouraged to evaluate their *sitio* (village) in terms of appropriate places for burning rubbish and the disposal of non-burnable rubbish. Then, the sources of clean water are assessed and potable water is defined. The intention is that the pupils should see themselves as participants in the development of their community and the preservation of their culture.

Conclusion

There is now a growing recognition of the potential of Indigenous Knowledge in resource management and sustainable development. There are also evidences that this knowledge is gradually disappearing. For the benefit of the future it is then important that measures be undertaken to collect and document the remaining indigenous knowledge in traditional communities and integrate it to modern education. Greater efforts should also be undertaken to strengthen the capacity of local people to develop their own knowledge

base and to develop methodologies to promote activities at the interface of scientific disciplines and indigenous knowledge.

As indigenous peoples have begun to reassert their rights to control over various aspects of their lives, modern schools should endeavor to blend indigenous knowledge with modern knowledge in ways that will provide them with wisdom to live a meaningful life under contemporary conditions.

The initiatives currently undertaken by indigenous peoples call for a significant paradigm shift towards the integration of indigenous knowledge systems and ways of knowing in the educational process. As this shift evolves, it is not only indigenous people who will be the beneficiaries, however, since many of the issues that are being addressed are of equal significance to in non-indigenous context (Nader; 1996)

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Myanmar

The Influence of Western Science and its Incommensurability in Myanmar Language, Culture and Scientific Concepts

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Abstract: The influence of western science and the interplay of local language and culture in science are presented in this paper. The discussion which follows is an attempt to use a philosophical framework of conceptual incommensurability through the translated meaning from the indigenous Myanmar language. The incommensurable terms in Myanmar is discussed from its cultural influence vis-à-vis western worldviews. The presentation is based on philosophical claims explaining the complexity from the original Sanskrit language and religious culture resulting in the incommensurability of meaning from western views. The inherent difficulty of clarifying the incommensurable concepts in science led the authors to use models, outline by Kawasaki (2002) to explain incommensurability embedded in the Myanmar indigenous science that could have arisen from philosophies intertwined through cultural practices founded in Buddhism. The consequent incommensurable terms are also explained through varying philosophers' views from language translation. This article is only a preliminary attempt to clarify and understand incommensurability of scientific concepts from the emerging influence of Western science to the indigenous Myanmar language on the interrelationship of language, culture and science.

Myanmar and Its Indigenous Language

Burma is the old name for Myanmar. The name Myanmar is given to a union of different tribal groups constituting a cultural mosaic of 135 ethnic groups with varying linguistic backgrounds. The term "Myanmar" embraces all ethnic diversities comprising the eight major indigenous groups Kachin, Kayin, Kayah, Chin, Mon, Bamar, Rakkhine and Shan. The Bamars are considered the ruling majority among the ethnic groups in Myanmar. The Union of Myanmar is further divided into seven states with seven divisions and Yangon is the capital City. Myanmar's population is approximately 53 million and Buddhism is the major religion. The Myanmar life is based and shaped by Buddhist principles. Alms giving is an everyday performance along with paying respect to the *Triple Gems: Buddha, Dhamma and Sangha.* Myanmar culture is strongly based on Buddhism and so the arts, literature and language have become highly enriched with Buddhist thoughts and words. Myanmar is also the term given to the language spoken by three-fourths of Myanmar's population or about 30 million people. The language belongs to the Tibet-Chinese family, having 42 alphabets with 32 consonants and 10 vowels. The distinctive Myanmar alphabet consists almost entirely of circles or portions of circles used in various combinations. The alphabet evolved at a time when writing was generally done on palm leaves, the letters traced by means of a stylus. Thus straight lines were impossible because they would cause the leaf to split. Myanmar's alphabet's source were the Brahmi script which flourished in India and spread to Tibet, Sri Lanka, Myanmar, Thailand, Cambodia

and Indonesia along with some Indian beliefs and cultures. The developers of the Myanmar scripts only took what was appropriate to Myanmar's language from Sanskirt, Pali, Pyu, and Mon and rejected what was not appropriate.

Myanmar is a tone, monosyllabic language which functions mainly by agglutination (McDavid, 1945; Okell, 1969; Shwe Thwin, 1966; Stewart, 1955; Tun Myint, 1993), its phonological system is based on vowels, consonants, and tones. According to Tin Hla (1978) the structural patterns of Myanmar words originated from the phonological criteria, a word of one syllable has one meaning. Myanmar have compound words or complex words of two or more monosyllabic nouns and verbs. Other words having new meaning are formed as dysyllabic-, trisyllabic-, and polysyllabic-word. As an agglutinative language cited by Pe Maung Ti (Than Htut, 1966). Water, for example is /jei/ and pot is /ou:/ showing the words are one syllable with one meaning. Thus, combining these two words, becomes another new word /jeiou:/ giving a new meaning "water pot" formed as dysyllabic word. By adding another word /thau'/ to /jeiou:/, it becomes another new word /thaujeiou:/ with a new meaning "drinking water pot " forming a trisyllabic word. There are also many different loan words borrowed from other foreign languages such as Pali, Mon, English, Hindi, and Chinese. In the study of (Khin Aye (1995), Myanmar language was influenced by the Pali language consequently from Buddhism and English from British colonialism, where, attempts had been made to force Myanmar language into either an Indo-European pattern or into a Pali pattern.

Educational Foundations and Science Education

Education has been highly valued since the time of the Myanmar kings. The monasteries were the learning centers located in the villages as the first form of schools. The monasteries did not only provided religious knowledge but also taught reading, writing and arithmetic which later became the first formal curricula. A venetian, name Nicolo Mannuci who visited, Myanmar in 1700 described Myanmar as a "*kingdom governed by pen, not by a single person which goes from one village to another without a paper or writin*g.''

In the 1940's realizing that education is the key social element in social and economic development, the government placed special emphasis on education. Towards this advancement, education policies were set as a priority and consequently changed Myanmar's educational system. Curricular reforms and teacher education programs were initiated with science education introduced in the country after the Declaration of Independence in 1948. Furthermore, the general science has been introduced and taught as Basic Science in Upper Primary level up to the Upper Secondary level since the "Welfare State Plan" 1952. A few Upper Secondary Schools however gave separate courses in Physics, Chemistry and Biology. Reforms and innovations were also carried out in science textbooks from the Upper Primary to the Lower Secondary levels with the revision of science curricula in 1977. The science textbooks were written in Myanmar even in the teaching science.

The Education Promotion Programmes were initiated in 1989 to promote the Basic Education Sector for two academic years. Towards the late 90's the relevance of science education was seen to shape Myanmar, as a competitive nation in Southeast Asia requiring extraordinary resources or heroic efforts to implement new educational reforms. It was also a means to respond to the economic needs, social crises and problems of the environment. This was introduced with a firm commitment to train adequate number of teachers and scientist for the rehabilitation and further advancement of Union of

Myanmar to be a scientifically literate country. To date, Myanmar is use in teaching science as printed in science textbooks from the primary and middle school levels. But after 1984 onwards, high school mathematics and science textbooks were in English, using bilingual approach in teaching science.

Following this new curricular innovation with major changes in the 1990's, the science education curriculum emphasizes on everyday coping; structure of science; science and technology, decision making; scientific skills development; and correct explanations of scientific thoughts. It also established relevance science textbooks emphasizing "science for nurturing, " "knowledge and quality of life," as well as concerns for the environment. With the current school situation in Myanmar, it reveals that science education is given a prominent role in the school curriculum through the provision of three elective science subjects like physics, chemistry and biology at the high school level and is the highest among the other combination of elective subjects. These recent Education Promotion Program are mainly concerned with Myanmar's vision and mission to cope with the challenges of an ever changing world.

Recently, the innovation in science education has improved effectiveness in Myanmar's Educational System. The research-based curriculum projects are one of the developing examples of improvements to solve real world problems in science education. Learners are engaged in guided, reflective inquiry through extended projects that inculcate sophisticated concepts and skills to generate complex products. Many science students have acted as partners in developing learning experiences and generating different perspectives on shared experiences, reasoned qualitatively about the physical processes, translated frames of reference learned from science and create local dynamic models. These curricular approaches has improved various types of learners and differentially enhanced students' performance in science.

Students' Worldviews and their Indigenous Culture

The goals in teaching science are to transmit knowledge, skills and values of the scientific community to students'. Unfortunately, substantial research shows that many multicultural learners have still varied notion and understanding of science from western origin, others simply assume what majority claim and understood about science, is what science means. Critical reflections on the understanding of what is science, provided reforms in science education directed towards "science for all", catering mostly to students with cross cultural backgrounds. The researches done specifically focused on cross-cultural studies which particularly awakened interest on the worldviews of science teachers and how their worldviews influence classroom practice (Lawrenz and Gray, 1995; Ogunniyi, Jegede, Ogawa, Yandila and Oladele, 1995). An interesting area that warrants more attention, is on the overall picture on how students' view the relationship between science and their traditional religious thought from worldviews.

A study conducted by Aikenhead and Otsuji, (2000) revealed that within the next decade, an increasing number of schools will face multicultural students where teachers scientific worldview will be in conflict with many of the students' worldviews (Atwater and Riley, 1993; Cobern and Aikenhead, 1998; Rodriguez, 1998). Parallel to these studies Lee (1997); O Loughlin (1992); and Rodriguez (1999) cited one challenge for science educators is to help teachers become more aware of the culture of Western science to prepare teachers on culture clashes in their classrooms in the future. Thus, this information will help educators identify appropriate learning strategies to benefit the

process of curriculum development in the future (e.g. Nord and Haynes, 1998; Roth and Alexander, 1997).

Driven by the goals "science for all,'' also implies that multicultural students' must 'learn how science really gets done," "understanding the seeming contradictions," "the methods of science", and the "so called real world". The documents on science literacy quotes:

> "People who are literate in science are able to use habits of mind and knowledge of science and mathematics and technology and have acquired to think about and make sense of the many ideas, claims and events that they have encounter in everyday life".(Benchmarks for Scientific Literacy, 1933, pp 322).

While these goals are desirable, improvements in the students views helps them make cultural transitions from school science, to understand connection between their home culture and the western science taught in the classrooms. The connection of "nexus" between a community's culture and the culture of western science is captured in phrase "science and culture nexus" (SCN).

The concept of worldview, however, did not come from sciences as historians have argued on the subtlety, complexity and diversity of relationships between science and religion (e.g. Brooke, 1991). To Brooke, defining science is notoriously difficult; it can never be characterized completely in terms of its theories, methods, and social organization. For example, part of what was meant by natural philosophy in the 17th century involved a discussion of "god's relationship to nature". Religious beliefs could operate with science, as Brooke concludes that religious concepts have sometimes functioned as primitive science, and scientific creeds have constituted alternative religion as cited by (Koul, 2003).

In the cited literature, the ideas on scientific worldview dates back from 1929 on the publication of the Vienna Circle's Manifesto, *A scientific world-view* written by Godel, Hanh, Neurath and Carnap. This manifesto took the concept of a scientific worldview to be synonymous with the logical positivism. The manifesto cited only meaningful sources of knowledge from logical reasoning and empirical experiences (Salmon, 1998). More recently, the concept of scientific worldview has appeared in education documents as Project 2061.

> A scientific worldview is not something that working scientists spend a lot of time discussing. They just do science, but underlying their work are several beliefs that are not always held by nonscientist. One is that by working together over time, people can in fact figure out how the worlds work. Another is that the universe is a unified system and knowledge gained from studying one part of it can often be applied to other parts. Still another is that knowledge is both stable and subjects to change. (AAAS, 1990. n.p.)

On the concept of worldview, an individual is incline to think that an original concept can lead to even broader representation than what would typically be considered from its original schema. Taking this example, if a science teacher is asked to draw a concept "nature" one could expect the map to be reasonably complex. The first might show "sea" that represents nature and its other physical attributes describing its characteristics. The teacher would likely proceed to draw relations of "organisms" to other aspects of science. This concept map with its interconnected parts will lends itself to metamorphic description of an "ecology", that is "conceptual ecology" (Toulmin, 1972) this represents

one's understanding on the concept of "sea". Moreover, ecology in nature can be defined narrowly like a (*e.g*. pond) or broadly to (*e.g* an ocean) and so conceptual ecology. The cited example can be further broadened to include "Oceanography" which contributes to the nature of other larger categories, even to the cycle of elements in nature.

If one continues to ask the teacher with the concept map, eventually at the broad level of "nature" would glimpse the person's scientific worldview. The teaching of scientific concepts also emphasizes the ability to discriminate between "acceptances of assertion", the "unverified end results", "models or conclusions" and the "understanding the on basis and origin of scientific concepts". On the other hand, however, the cultural claims on recognizing questions like "how do you know?", "why do you believe that?", "what are the evidence for?" have not been address, answered and understood and when something is being taken on "faith" (Aron, 1983).

Similar capabilities have been also included in the notion of intellectual independence by (Munby, 1980; Aikenhead, 1990; Norris, 1997). Without such understanding of science, students' are easy prey to dogmatist, flimflam artist and purveyors of simple solutions to complex problems, including respectable people who intimidate learners through their mode of discourse unfamiliar to many (Hudson, 1998). The authors of "Science for All" recognize science, to be encompassing across cultures and belief. The understanding of science can provide knowledge to develop effective solutions to global and local problems, foster respect for nature, recognize uses of technology without cultural bias and those which endanger and recklessly destroy life support systems.

On this premise of cultural clash or incommensability, how do students move from their own culture and beliefs? Researchers like Phelan et al, (1991) as cited by Aikenhead & Otsuji (2002) explains that "when cultures are congruent in supporting smooth transitions, students' can move from their own culture and beliefs however, their highly discordant cultures resist transitions that likely determine students capability to learn Western science."

Myanmar's Religious and Cultural Background

According to Houtman, (1999) Myanmar's culture is composed of four strands: the indigenous culture, pre-Buddhist culture, Buddhist culture and post-Buddhist culture. Its indigenous culture is a secular (in sense *loki*) religion influencing the mode of livelihood that includes the spirit to "promote peoples material being'. Related to this is the tribal ancestor worship which is very common among races of Mongoloid origin based on normal tribal ancestor–worship that allows an extended family as a social organization. The culture is strongly based on Buddhism attained from *Mahayana* and *Theravada* Buddhism accommodating a belief on the chief pagodas incorporating the spirits.

The *Theravada* represents a significant landmark in the cultural advancement of Myanmar people for formal education. The introduction of the *Tipika* to Burma by *Buddhagnosa* and by *Arahan* was significant as the source of moral advancement for all. Education in monasteries went beyond moral and spiritual, to include all forms of knowledge, such as secular arts and crafts. The *Mangala sutta,* consist of thirty eight rules which is part of the moral education "forming the very foundation of cultural refinement for the Myanmars, moral and social influence by Buddhism. The Buddhist teachings brought "moral control and moral balance" through *Majjimapatipada, Brahma Vihara* and *Hiri Ottapa* which were preventive in minimizing the social problems arising out of material progress".

Myanmars pre-Buddhist culture is the result of the Asian influence compared to western influence, more on the impact of new technology, regionalization and globalization. Burma has been in close touch with Asian countries, which have things in common in harmony with culture especially on the understanding of faith in Buddhism. The impact of western culture as cited by Houtman, (1999) was more harmful than contributory to Myanmar's culture.

Myanmar's Philosophical and Cosmological Beliefs

Myanmar's culture and philosophical views are strongly influence by Buddhism. Buddhism teach "Buddha's way of viewing things rejecting atheism, theism, monism, and dualism alike". Buddha is a historical person, neither an imaginary being nor God who criticized all concepts of the metaphysical. The non-being an inextricable truth of Buddhism. In the teaching of Buddhism, Buddha obtained perfect knowledge and wisdom having walked along the right path led him as a destiny. The teaching based on practical ways for an individual to reach (*Myaung Mya Sayadaw U Nyanika*: Agga Maha Pandita, 1999). In Buddhism, "*Buddha"* the "teacher"; "*Dhamma"* the "teaching" and "*Sangha"* the "followers" who are called the "Community of Brotherhood' or the 'Holy Order'. Myanmars uphold Buddha as guide and believed his teachings for wisdom accepting *Dhamma* as a way to practical conduct and Sangha as the bearer of the Dhamma's torch. In this manner, these three fundamentals are the most valuable teachings for Buddha's disciples. Aa a practice, Buddhism rejects reverence of supernatural doctrine. As the Buddha quotes:

> Do not accept anything by mere tradition. . . Do not accept anything just because it accords with your scriptures. . . Do not accept anything merely because it agrees with your pre-conceived notions. . . But when you know for yourselves -- these things are moral, these things are blameless, these things are praised by the wise, these things, when performed and undertaken, conduce to well-being and happiness -- then do you live acting accordingly.
>
> -- the Kalama Sutta, Anguttara Nikaya III. 65

In earliest form of Buddhism, the Theravada, any metaphysical essence or being underlying the play of phenomenal experience is rejected. No 'soul" or permanent self is recognized, and the perception of a continuous identity was held to be an illusion.

> Any feeling whatsoever, any perception whatsoever, any mental processes whatsoever, any consciousness whatsoever -- past, future, or present; internal or external; blatant or subtle, common or sublime, far or near; every consciousness -- is to be seen as it actually is with right discernment as "This is not mine. This is not my self. This is not what I am."
>
> -- the Anattalakkhana Sutta, Samyutta Nikaya XXII. 59

The original positive Buddhist contribution to the field of metaphysics is *pratītyasamutpāda*, which arises from the Buddhist critique of Indian theories of causality. It states that events are not predetermined, nor are they random, and it rejects notions of direct causation owing to the need for such theories in the Indian context to be undergirded by a substantialist metaphysics. Instead, it posits the arising of events under

certain conditions which are inextricable, such that the units in question at no time have independent existence.

> This being, that becomes.
> From the arising of this, that arises.
> This not being, that does not become.
> From the ceasing of this, that ceases.
> --- Samyutta-Nikaya ii. 28

Language, Beliefs and Incommensurability

The term incommensurability has been used very successfully in the recent discussions in the philosophy of science, and the echoes of the debates about the value of incommensurability. For Kuhn (1969), the idea of incommensurability is strongly linked to that of the paradigm. Thomas Kuhn, as well as P.K. Feyerabend, understood incommensurability as the unintelligibility of affirmations between different domains of discourses. According to this interpretation of incommensurability, those statements of one domain lack sense if they are introduce in a different one. Both authors used this concept to oppose the positivistic idea of development in sciences as a lineal process of progressive accumulation of knowledge Alarcon (2003).

Does incommensurability or representation explains the idea that "different languages carve the world up in different ways and as a result their speakers think about it differently"? Incommensurability from the stand point of a realist, pertains to cases where representation aims to approximate an object (whether the object of representation is three dimensional, space, inner consciousness, social reality or any other dimension of the real. Moreover, the notion of incommensurability as interpreted can precisely deal with cultural and artistic phenomena that proclaim the realist attachment to the world.

From a positivist stand point, it condemns natural language for its ambiguity to artificial languages where words have only one clear cut meanings. Swoyer's (2003), article citing Whorf-Hypothesis or the Whorf-Sapir Hypothesis explanation on incommensurability, many thinkers have also explained that the extent and kind of language leads to differences in experience and thoughts. Whorf and Sapir believed that language embodies a worldview that "speakers of different language from varied cultures think about the world differently" leading to incommensurability.

The two paradigms on "Linguistic Diversity" and "Linguistic Influence of Thought" also claim and suggest that speakers of different language think about the world in quite different way. Like many other relativistic themes, particularly the work of Johann Georg Hamann (1730-88), Johann Goottfried Herder (1744-1803) and Wilhelm von Humboldt (1767-1835) defended by diverse thinkers Ernst Cassirer and Peter Winch quotes;

> "The distinctions which here are taken for granted, the analysis of reality in terms of things and processes, permanent and transitory aspects, objects and actions, do not precede language as a substratum of given fact, but that language itself is what initiates such articulations and develops them in its own sphere" (Cassirer, 1946 p 12)

This hypothesis came to prominence through the work of Edward Sapir and his student Benjamin Lee Whorf often called the Sapir-Whorf hypothesis or simply the Whorf Hypothesis;

> "Human beings do not live in the objective world alone, nor alone in the world of social activity as ordinarily understood, but are very much at the mercy of a particular language which has become the medium of expression for their society. It is quite an illusion to imagine that one adjust to reality essentially without the use of language and that language is merely an accidental means of solving specific problems of communications or reflections" (Sapir, 1929, p.209)

To Sapir, language also affects how human mind perceive things:

> Even comparatively simple acts of perception are very much more at the mercy of the social patterns called words than we might suppose …. We see and hear and otherwise experience very largely as we do because language habits of our community predispose certain choices of interpretation (p.210)

But the differences do not end with perception:

> the fact of the matter is that the 'Real world' is to a large extent unconsciously built up on the language habits of the group. No two languages are ever sufficiently similar to be considered as representing the same social reality. The worlds in which different societies live are distinct words, not merely the same worlds with different labels attached" (p.209)

> "We dissect nature along lines laid down by our native languages. These categories and types that we isolate from the world of phenomena we do not find there because they stare every observer in the face; on the contrary, the world is presented in a kaleidoscope flux of impressions which has to be organized by our minds—and this means largely by the linguistic systems in our minds" (p.213)

> ….. no individual is free to describe nature with absolute impartiality but is constrained to certain modes of interpretation even while he thinks himself most free (p.214).

In fairness, these passages come from a single essay. "Science and Linguistics" of 1940, which expresses Whorf's ideas on language and thoughts;

> …..users of markedly different grammars are pointed by their grammars toward different types of observations and different evaluations of extremely similar acts of observations, and hence are not equivalent as observers but must arrive at somewhat different views of the world (1956, p.221).

And yet Whorf's third essay;

> "facts are unlike to speakers whose language background provides for unlike formulation of them" (1956, p.235)

According to Whorf's essay, human languages are flexible and are extensible, so most things that can be said in one language can be approximated in another; if nothing else, words and phrases can be borrowed ("Schadenfreude, je ne sais quoi" in the original German translation). But what is easy to say in one language may be harder to say in the second, and this may make it easier or more natural or more common for speakers of the

language to think in a certain way than for speakers of the second language to do so. A concept of category may be more available in some linguistic communities than in others (*e.g* Brown, 1956, pp.307 ff) cited by (Swoyer, 2003). In short, the linguistic relativity comes in stronger and weaker forms, depending on the hypothesized forms and the hypothesized strength of the hypothesized influence.

Cultural Clash or Incommensurability

The following 'terms' are illustrative examples of incommensurability following Kawasaki's (2002) model. This provides a framework to understand incommensurability on Myanmar translation, which are irreconcilable between the local and western views.

The cultural understanding of term "nature"

In Myanmar it means "*dhaba wa"* translated to mean "*something inevitable"* a matter which happened automatically without human effort and creation (MED, 2003). The term "nature" also means *"a phenomena on direct sensation on the human experience as a result of an interaction with the material substance occurring naturally*."

It further is linked to humans' worth of being able to experience *"natures existence"* and expressions make him accountable for continuity and balance. This traditional meaning is expressed on the so called "laws *of nature*" with the indigenous beliefs of Myanmar laid on a historical justification from Buddhist teachings differentiating western science from traditional origin. Myanmars cosmological beliefs relates no supreme being creating the universe which is a composition of mind and matter. "Nature" constitutes the six laws of the universe namely, *Pathavi* (Law that solidifies), *Apo* (Law that liquefies), *Tejo* (Law that gives cold and heat), *Vayo* (Laws on motion), *Akasa* (Law that makes space), and the *Mano* (Law that causes the continuous process of Mind). "Nature" has also four inseparable laws on matter: *Pathavi, Apo, Tejo and Vayo,* collectively called "Paramanu". The formation and disintegration of *Paramanu* is very great within seconds, that birth and death of *Paramanu* can take place several thousand times. Both mind and matter are part of "nature" which can disintegrate very quickly. In Myanmar's belief, there were numerous world that has existed even in the past even before the present which were part of "nature" itself and no one knows when the first world was formed and the who were the first being born (U Maung Nu, 1983).

The explanation on the of metaphysics "*pratityasamutpuda",* in Buddhism is linked to the belief in *"*nature". The *"events are not predetermined, nor they are at random and it rejects notions of direct causation*". Instead, it posits the arising of events under certain conditions which are inextricable from "nature" with no origin. This process of encounter and interpretation provides incommensurability between western science and indigenous Myanmar teachings unable to separate "spiritual substance distinct from materials". The existence of the world of eternal truths separates the world of appearance and transitory elements at present. It is also evident that Myanmar beliefs doesn't conceive the existence of what is 'material from spiritual' in measure.

In Myanmar, transported colonial western science is introduced from textbooks and curricula rooted in western assumptions about "nature as reality" as compared to the local knowledge from the philosophy of Buddhism. The western worldviews of "nature" are formed to describe its physical attributes by theories and explanations. The scientific knowledge about nature is not about its objective "truth" but is results of empirical facts, which are supported by logical observations. According to empiricism, science does not

make any statements how nature actually "is" it can only make conclusions based on observations and empirical evidence. To take a couple of representation, there is standard characterization to describe it guided by principles of systems and categories on the laws of nature.

The term "observe" and its relation to western science

The meaning of observe in Myanmar is "*lei. la/ saun kji"* which means to study and watch. It further explains possession of a mental category "*of being*" becoming knowledgeable and sensible to explore material substance. It asserts fundamental configuration of the mind recognizing things it sees. The Buddhism's teaching on the capability of the mind rest on six kinds of Arammana (sight, sound, smell, taste, touch and thought), is called Samadhi. Through the Samadhi, one can observe the body and mind. "Observing" the true nature of the body and mind, is the beginning that will eventually lead an individual to attained *"Panna*". Myanmar people following Buddhism daily practice and cultivate five precept called " Sila" observing good things.

In Buddhism, the *Pratitya-samutpada* belief goes on to posit that certain specific events, concepts or realities are always dependent on other specific things and cant be observed vividly but happens. *Craving /a tha pjin: pja*/, for example, is always dependent on, and caused by emotions /sei hlou' sha: hmu/. *Emotion is always dependent on contact with surroundings, like* "to observe". The chain of "causation" purports to show decay, death and sorrow is indirect and not observable. In the same manner, the "*cessation of craving"* is ultimately an encompassing stillness which cannot be directly or visibly observed as happens.

Another philosophical framework of incommensurability is the translation of perceived terms to Myanmar, which does not fit into categories of spiritual and corporeal. The language translation provides the fundamental configuration to linked terms into particular articulations of which both are irreconcilable on bridging "spiritual frameworks" and translation.

"Practice" is a way of life grounded in Buddhism teachings

The Myanmar equivalent word for "practice" is /alei akyin/ which means "acquisition of a habit", " becoming accustomed to", "taking interest in", or "taking effort repeatedly" (MED, 2003). "Practice" is taught from Buddhisms influence "*doing to attain Nibbana*" *a mental state after eliminating all defilements and the end of rebirth*. It is to acquire *"Sila"*, *"Samadhi*" and "*Panna"*. "Sila" is a Pali word which literally *means the good habits of good persons.* If the person refrains from killing others, stealing, committing adultery, telling lies with the intention of deceiving others to their disadvantage and partaking of intoxicating drinks and drugs. This observance is to do the five precepts known as "Sila". The practice of "Samadhi" is attained by mental concentration.

It is to be noted in Buddha teaching for Myanmar people that only when there is Dhamma theory (Pariyatti), there is practice (patipatti), and only by practicing, there is realization of truth (Pativevedha). Hence, a person who enters into Vipassanā (meditation) practice should be well versed in the ground work of fundamentals of the Buddha dhamma. We should not be satisfied with more theory; we should practice by ourselves to be generous, moral, and mentally developed by "word", but by "work". When we practice Vipassanā, the moral of observing consciousness (insight knowledge) will disffuse all over your mind and body. The practice of Vipassanā is the only way which can forestall any latent danger of falling into woeful planes in the next rebirth (Mehm Hla Aung Gyi,

2003). Therefore, Myanmar people observe the precepts and practice meditation for the practical Dhamma. It indicates that Buddha Dhamma is quite natural and more scientific than sciences because Buddha Dhamma is not the truth by "word" but the truth by "work".

From historical roots, the indigenous meaning of the words "nature", "observe" and "practice" are strong reflections of the Buddhist influence to explain the incommensurability from philosophical views. The objectives of primary science curriculum, "to promote interest in natural phenomenon by observing while exploring" is the western worldview taught in the classrooms. In the translation of "observe" the most appropriate word "su:zan lei.la" should be used which means "investigate and study" instead of the dictionary meaning "*lei la/ saun kj*" to explain scientific concepts suitable to scientific worldviews.

Conclusions

The universality of science has unfortunately, been misunderstood when translated creating a uniform cultural view of the nature of science. Radical differences are projected between western thought and the school science. This perception has occurred underlying cultural issues from a language heavily influence by religion. In its simplest term, science is about building or making explanations to make sense of the world. Students are natural scientist curious about the world that need forging explanations on their perception of things that exist, the optical illusions including the limitations of vision in science are part of what has remained to be explained. The issue of science education is furthermore the practical explanations to understand science and practice it.

The alternative explanations can be use to explain natural phenomenon on the practical and even on the aesthetic level. On the cognitive dimension on the propositions, images, procedural are often incomplete and hold contradictory elements that distorts students real understanding of science.

Moreover, the image of science in Myanmar language is the product of the representation and translation of western science; similarly Ogawa (1998) describes Indian science on the "true" nature of science. The studies of Layton et al. (1993) encourage the deep investigations on these translations of knowledge that will enhance the relevance of worldview theory in science education. Further research should be conducted assessing how students as well as teachers understand science rooted from their indigenous knowledge, cultural values and traditions. A science educator would do well to consider the role of worldviews on science to unify students cultural and worldviews in science. There are still Myanmar terminologies on scientific concepts which have no exact equivalent, it is imperative to consider developing exact terminologies by Myanmar scientists, science educators and linguists to minimize LCI in Myanmar science.

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Vietnam

Language-Culture Incommensurability in Vietnamese Science

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Introduction

Language and culture are inseparable. If we believe in the dualist-monoist divide then the situation in Vietnam is a contradiction because Vietnamese is deeply rooted in Chinese (70% of the vocabulary is of Chinese origin; this stemmed from a millennium of domination of Vietnam by the Chinese), but our science curriculum is well placed in the Western tradition

It was the French who imposed their education system on Vietnam; later, this Western tradition was reinforced in the South by American influence and in the North by Russian influence).

Analysis of the content of science, its philosophical basis and the medium of instruction for science in Vietnam vis-à-vis science in Western countries

In Vietnam, science is taught from year 3 to year 12. In primary school, it is taught in one broad subject called Science. But from year 6 up, it is split into specific subjects such as Mathematics, Physics, Chemistry, Biology, Geography etc. The philosophical basis is totally Western, for reasons mentioned above.

The language of instruction has been Vietnamese for more than half a century now, even though in the past French was the language of instruction. The change from French to Vietnamese as the language of instruction has been seen as a victory of the nationalist movement in Vietnam, and it has been the result of enormous efforts from linguists and scientists to develop a system of terminology for every science (eg, Physics, Biology, Medicine, etc). The Vietnamese people are proud that their language is capable of expressing every scientific concept there is on earth.

The philosophical and cosmological beliefs of Vietnam

In Vietnam, there seem to be no creation myths – or if there are, they do not seem to be important. What is more important for a Vietnamese is how the Vietnamese came into existence. There is a legend about the origin of the Vietnamese people which everybody, even a child in primary school, knows of. In fact they learn this legend in schools.

This is how the legend goes: Lạc Long Quân, son of the Dragon King, met Âu Cơ, daughter of the King of Birds in one of his trips to the Red River Delta. They fell in love and decided to get married even though they did not belong to the same species, so they settled down where they met and became husband and wife. Later Âu Cơ gave birth to an egg which, when hatched, turned out 100 sons. The couple lived together until their sons were grown-ups.

One day Lạc Long Quân said to Âu Cơ: I've been away from my family for so long, and it's time I went back. But since I am a dragon and you are a bird, I cannot take you home because my folks will not accept it. Our ways of life are so different.

So they decided to separate, Lạc Long Quân going to toward the sea and Âu Cơ going to the mountains, each taking 50 sons. But the oldest son who should go with the father decided stayed where he was and became King Hùng (courage), the first king of Việt. The Vietnamese people now are direct descendants of King Hùng who live on the plains, but people who live by the sea and those who live in the mountainous areas are also our close relatives.

From the legend, it can be pointed out that we take the universe as already existing, and this is accepted as the unquestionable truth. There seems to be no quest for the real cause of the universe - ie, what was there before.

The philosophical viewpoint of the Vietnamese can be said to be one of pragmatism and humanism. They are not dogmatists or fanatics who would die to protect a theory. The most important thing in life for them is to be able to live in peace and wealth. This pragmatism is well reflected in the language: Vietnamese is a great borrower of world languages, especially Chinese and French. In fact, Vietnamese is similar to English in that we have a lot of words that exist in pairs, one of Chinese origin (like those of Latin origin in English) and one of pure Vietnamese origin. Words of Chinese origin are bookish, formal, while those of pure Vietnamese origin are spoken and informal. A few examples:

- worker = công nhân; thợ
- heaven = thiên đường; trời
- teacher = giáo sư; thầy dạy học
- parents = song thân; cha mẹ

A few borrowings from French and English:

- xà bông, xà phòng = soap (savon)
- xa lông = sofa (salon)
- pêđan = pedal
- tivi = TV
- top ten = top ten
- hooligan = hooligan

Analysis of incommensurabilities underlying the meaning of key terms in Vietnamese science

Let's take the word nature. In Vietnamese, it can be translated into 2 different words:

- thiên nhiên (same as Chinese word 'tiandi') (before 1975)
- tự nhiên (first word changed from 'thiên' = *heaven* to 'tự' = *self*) (after 1975) → to separate the natural from the supernatural

Observe = quan sát (guancha)
Practice = thực hành (same as Chinese)

For Vietnam, LCI does not seem to be a problem, because we already have our own system of terminology. In the past, in translating new terms linguists always had to go

through Chinese and use words of Chinese origin. However, the tendency now is to increase the use of pure Vietnamese words whenever possible to promote our own language. This change can be reflected very clearly in the difference in the coinage of new terms. Older Vietnamese living overseas would try to coin terms using Chinese words, or else use direct borrowing; people in Vietnam would coin new words using pure Vietnamese words, such as:

- software = nhu liệu (material that is soft); phần mềm (part that is soft)
- hardware = cương liệu (material that is hard); phần cứng (part that is hard)
- monitor = monitor; màn hình (frame that show picture)
- floppy disk = floppy disk; đĩa mềm (disk that is soft)
- laptop = laptop; máy tính xách tay (computer that can be carried by hand)

Australia

Language-Culture Incommensurability in Science in Non-Asian Indigenous Peoples

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One of the definitions of the term Indigenous Peoples is that they are the traditional inhabitants of their lands prior to colonisation by foreigners (Burger, 1990). A number of other terms are used to describe them, including First Nations Peoples, Aborigines and ethnic groups. There are some common attributes amongst the indigenous groups, of which their connection to the land is paramount. Some of these groups of peoples live in regions which were colonised by European colonisers since 1500 and which are now recognised as developed countries. In this paper I will confine myself to four of these countries: Australia, Aotearoa New Zealand, the USA and Canada. The Indigenous Peoples identified from each country are listed below.

- Australia: Aborigines, Torres Strait Islanders (more than 350 language groups [sometimes described as tribes]; considered to have lived in Australia for at least 40 thousand years)
- Aotearoa New Zealand: Maori (a number of *iwi* [tribes] which trace their identity to the *waka* [canoes] that originally brought them to Aotearoa; many Maori express affinity to more than one *iwi*; one language with a number of dialects; Maori represent 15% of the population)
- USA: Native Americans (American Indians), Alaskan Inuit (Eskimo), Native Hawaiians
- Canada: First Nations People, Inuit

A number of these groups are also related. Maori and Native Hawaiians are Polynesian groups, as are the inhabitants of many of the islands of the Pacific, and their languages have common elements. Inuit from Canada, Alaska and Russia have a common origin and similar indigenous languages. Native Americans and Canadian First Nations people share a common ancestry; however they disagree with the scientific determinates for their origins (i.e. that they migrated from Asia during the last ice age, 12-18 thousand years ago).

Indigenous Peoples also live in other countries (e.g. Dyaks in Borneo [both in Malaysia and Indonesia]; Saami in Sweden, Ainu in Japan) but usually no allowance is made for cultural difference in the science curriculum. Burger (1990) listed 20 groups of Indigenous Peoples in the South East Asia region but this list may be incomplete. Some displaced indigenous people have been resettled in the First World countries (e.g. many Hmong, a hill tribe from Laos, were resettled in the USA as a result of the Vietnam war).

Legal criteria for identification of indigenous peoples vary between countries. The Australian legal system has defined an Aboriginal or Torres Strait Islander person as someone who satisfies the following three criteria:

- be of Australian Aboriginal or Torres Strait Islander descent;

- identify as an Australian Aborigine or Torres Strait Islander; and
- be accepted as an Australian Aborigine or Torres Strait Islander in the community in which she or he lives, or has lived.

The science curriculum

Australia: In Australia, the national curriculum, *A statement on science for Australian schools*; (AEC, 1994a) is outcomes-based. There are 5 strands (4 conceptual strands and one process strand called Working scientifically). The conceptual strands are Life and living, Planet earth and beyond, Energy and change, and Natural and processed materials. A national profile, *Science-a curriculum profile for Australian schools,* was developed for each of the strands, each divided into sub-strands, at eight levels between years 1 and 10, although it was considered that most students would reach level 6 by the end of year 10 (AEC, 1994b).

However the state and territory education authorities (8 separate authorities) are not obliged to use the national curriculum although all of them have used it to some degree. Some states and territories have developed curriculum frameworks – i.e. outcomes linked to year levels.

There is no special provision for indigenous students. Some authorities have developed resource materials for indigenous students and for teachers. Most instruction of indigenous students is in English; use of local languages for teaching science would be restricted to some bilingual primary schools, mainly for aspects of cultural knowledge.

New Zealand: A national curriculum, *Science in the New Zealand Curriculum*, has been developed and taught over the past ten years (NZ Ministry for Education, 1993). It has achievement objectives in six learning strands at 8 levels of achievement over years 1-13. The learning strands are divided into two groups:

- *The integrating strands*: Making sense of the nature of science and its relationship to technology; developing scientific skills and attitudes
- *The conceptual strands*: Making sense of the living world; Making sense of the physical world; Making sense of the material world; Making sense of planet earth and beyond.

All students are instructed in English; this includes the majority of Maori students who attend western-style primary and secondary schools.

The Maori version of the national curriculum (*Putaiao i roto i te Matutanga o Aotearoa,* 1996) is basically a translation into *te reo Maori* (Maori language) with some reorganisation of the English language document (Barker, 1999; Bell, 2005; McKinley, 1996); other Maori-language curriculum documents have been developed in mathematics and technology. *Putaiao* doesn't contain any specifically Maori knowledge or nature of science unless related to the mainstream curriculum. *Putaiao* is only used in Maori language medium schools which cater for a minority of Maori students.

As part of writing the curriculum in *te reo Maori* the writers consulted with the Maori Language Commission regarding the use of technical terms. The Commission's guidelines for developing new terms were that the word must be short, transparent and not a loan from English. Thus it appears that the Maori language is avoiding using an

international terminology for scientific and technical language which other countries are adopting (McKinley, 1996).

United States: National standards were developed by the National Science Foundation and have been incorporated into all states' science curriculum documents; there is regular and rigorous testing related to standards.

There is no special provision for indigenous people; locally-produced materials usually show links to the standards. There has been some development of culturally responsive science curriculum handbooks (e.g. Nelson-Barber & Estrin, 1995) and resources which integrate traditional knowledge and science (e.g. Stephens, 2000). Some organisations have developed cultural standards for students, educators, schools and curriculum (e.g. ANKN, 1998).

Canada: The *Common framework of science learning outcomes, K to 12* was published in 1997 by the Council of Ministers of Education, Canada (CMEC) and they have informed the development of science curriculum by the Canadian provincial and territory educational authorities. Canadian is officially bicultural in English and French, so there is a French version of the *Common framework.*

There is no specifically First Nations science curriculum but there has been development of resource materials, some by indigenous groups and others in collaborations between indigenous and non-indigenous peoples (e.g. *Rekindling traditions,* Aikenhead, 2001). These often focus on explaining the western science behind an indigenous object or practice. Most teaching of indigenous students takes place in one of the two national languages, English or French. However, in some areas (e.g. the territory of Nunavut) there are bilingual programs so that teaching in some of the primary schools could be in indigenous languages.

The philosophical and cosmological outlooks of the indigenous groups in Australia

Indigenous peoples are generally considered to have holistic philosophical outlooks, much similar to those of Asians. For most of them there is no God-being or beings but rather the people have a spirituality which is derived from the closeness of their relationship with nature. Figure 1 looks at the difference in worldviews between Western and Indigenous peoples; again the position of Asians would be considered to be towards the indigenous end of each spectra.

Western worldview	**Indigenous worldview**
Materialistic	Spiritual
Reductionist	Holistic
Rational	Intuitive
Decontextualised	Contextualised
Individual	Communal
Competitive	Cooperative
Explains mystery	Celebrates mystery
Time is linear	Time is circular
Seeks power over nature and people	Seeks to coexist with nature and people

Figure 1: A comparison of western and indigenous worldviews (from NTDE, 1999)

It is possible to see that there are areas of common ground between western science and traditional native knowledge (Figure 2). Similar diagrams can be drawn at the topic level, to compare western scientific knowledge and indigenous knowledge, for example, on crocodiles. Western knowledge may include lots of detail on reproductive knowledge; common knowledge may relate to their reproduction from eggs and where they build nests; indigenous knowledge would be about the totemic relationships. The Venn diagram, another western model, tends to oversimplify our understanding. What westerners see as important is the knowledge aspect, whereas indigenous peoples (and Asians) would see the relationships as being more important.

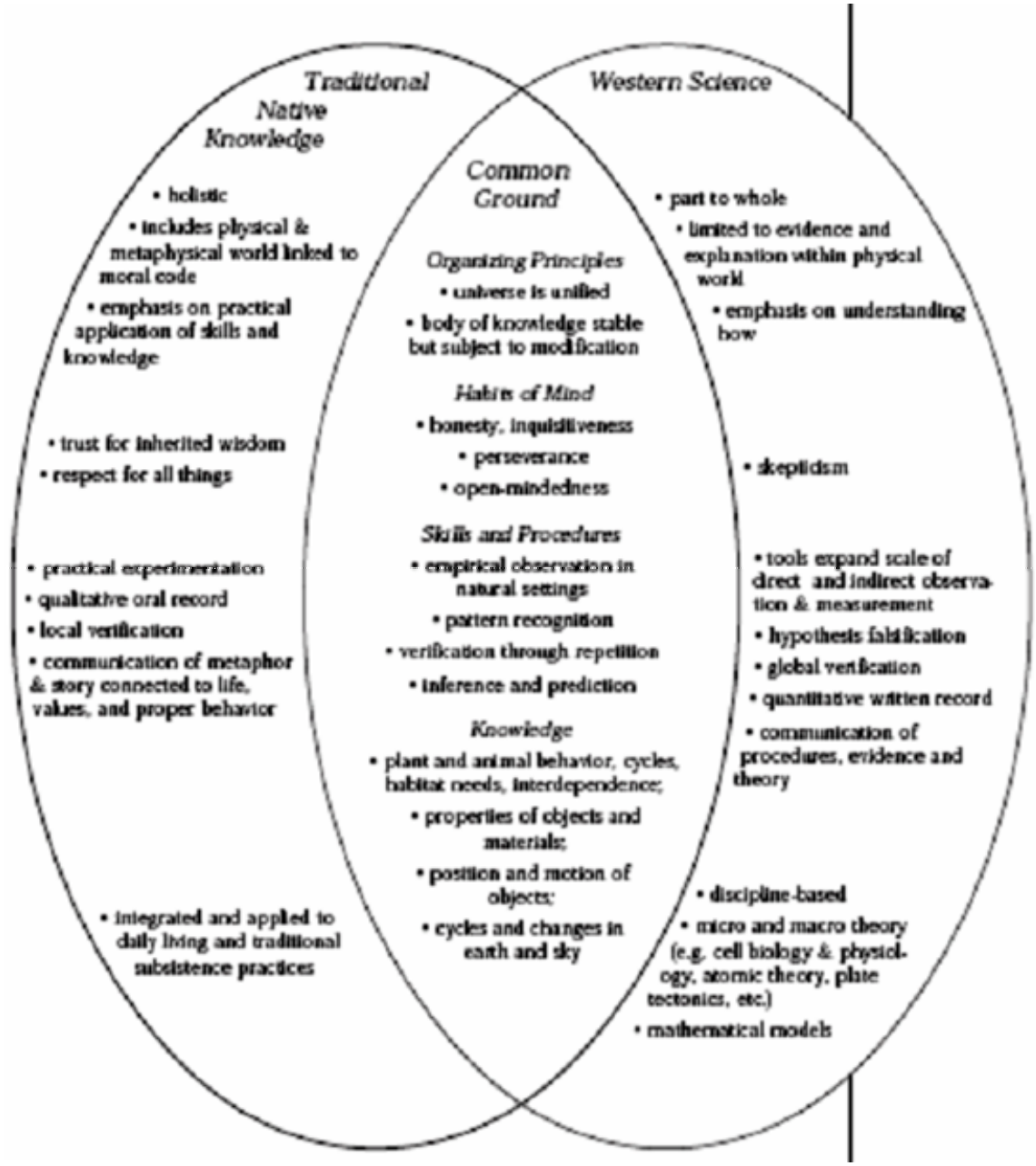

Figure 2: Fields of knowledge involving traditional native knowledge and western science, including common ideas (from Stephens, 2000)

The cosmological beliefs of Australia's indigenous groups – creation myths and origin of the universe

> *Everything under creation is represented in the soil and in the stars. Everything has two witnesses, one on earth and one in the sky. ... Everything is represented in the ground and in the sky.* (Mowaljarlai & Malnic, 1993, p.5)

In Australia, all indigenous groups believe in Creation Beings which are responsible for the creation of the world, the landscape and all creatures in it. However the creation stories differ between language groups. The creation time is referred to as the Dreaming or Dreamtime. Some creation beings still exist and are either active within the landscape (such as the rainbow serpent which causes rivers to flow and rain to fall), or live in sacred places. Disturbance of some sacred places may cause the creation beings to awaken and cause damage. Indigenous people see themselves as caretakers of the land and of its sacred places, and they need to follow particular rites to ensure the well-being of the land. Some sacred places (e.g. Uluṟu [Ayres Rock]) are considered sacred by indigenous people from a number of language groups surrounding the area.

Just as there are numerous Australian indigenous languages, there are numerous cosmologies. However according to Johnson (1998) there are a few basic tenets that underpin a general understanding of Aboriginal cosmology.

- Nature and society were formed at the same time by creative spirits who wandered the earth during an eternal time and which still exist (this time is called the Dreaming)
- The ancestral spirits still exist but are no longer visible, having withdrawn from human view
- The earth and life itself were in existence when the creative powers began their business.
- The task of humans is to maintain the ecological balance, being ultimately responsible for the ongoing harmony between natural and cultural systems.

Some universal or widespread themes have been identified (Johnson, 1998). Most Aboriginal people held a common view of the earth as a flat disk surrounded by the boundless ocean. Above the earth was a solid vault or canopy, and above this the sky world which was supported by props of one sort or another.

As the quote from Mowaljarlai & Malnic (1993) above suggests, Aboriginal cosmologies are reflected in the lives of the people. Figure 3 indicates how the cosmology of Yolngu people encompasses many aspects of their lives.

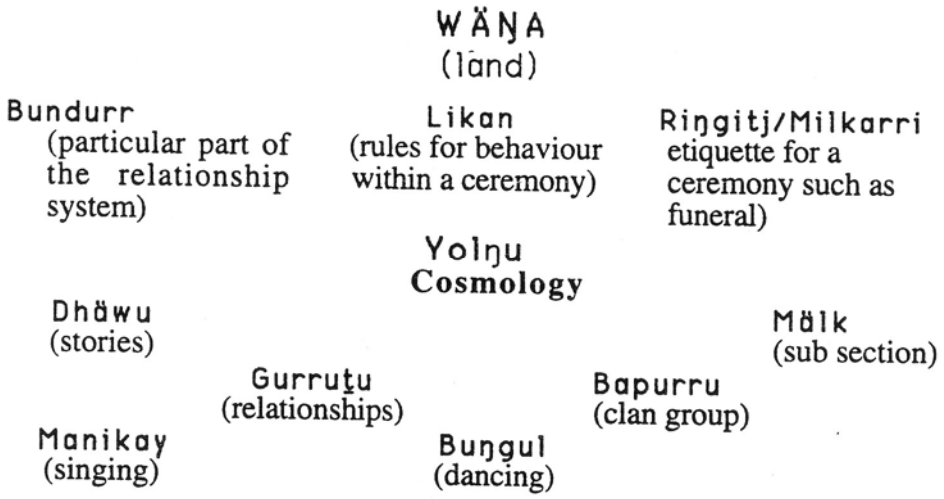

Figure 3: A conceptualisation of the elements of the Yolngu cosmology (the Yolngu are the traditional owners of the lands of Northeast Arnhemland; from Kepert, 1991)

Language-culture incommensurability in science in Australia

All Australian Indigenous languages would be considered incommensurable with English. In the same way as Kawasaki (1996, 2002, 2005) suggests that Japanese linguistic articulation is independent of the Standard Average European (SAE) and the Japanese worldview shows linguistic or cultural incommensurability with the western scientific worldview, Australian Indigenous languages also developed independently of SAE and the worldviews are thus also incommensurable. All Australian Indigenous languages are oral languages with small numbers of speakers. Many of them have been translated into English at some time, although there are some which have become extinct and others which are in danger of becoming extinct and have not been translated.

Aboriginal students live in a range of settings with a large proportion of Aboriginal students living in urban areas and attending the same schools as other Australians. For most of these students their first language is probably Aboriginal English, a variant of Australian English which is more common in regional centres and cities; however instruction in schools is in Australian English and this can be the cause of some tension. Some students may be users of an indigenous language, depending on how recently their family moved to the urban areas, but for many their knowledge of an indigenous language will be limited and incorporated into Aboriginal English. Ideas of world view are confused in settings such as this; traditional stories may be passed on in Aboriginal English but most inputs for students through school and the media are in Australian English.

Aboriginal students in communities away from the cities and towns usually speak at least one indigenous language as their first language and possibly dialects of that language, and are usually English as a second language speakers. Some students are taught in bilingual schools, where their early learning is in their mother tongue but is replaced by English as they progress through school. More frequently the indigenous languages are used informally between students, indigenous assistant teachers and indigenous teachers (who are a minority of teachers). Mostly teaching is in English as there are not many Indigenous teachers and few western teachers have sufficient language skills to teach in language. In some communities students may speak Aboriginal Kriol

[Creole] or Aboriginal English which are variants of Australian English; this is more common in regional centres and cities.

Analysis of incommensurabilities underlying the meaning of key terms in science

Because of the incommensurabilities between English and Australian Indigenous languages, some of the common scientific terms such as nature, observe and practice don't translate simply to Indigenous concepts. The following is an account of a conversation I had with an Aboriginal woman.

I spoke to Didamain Uibo, a friend of mine, who's an Aboriginal woman and a speaker of the Nunggubuyu language from around Numbulwar on the east coast of the Northern Territory of Australia. This is her first language; she also speaks Anindilyakwa (the language of Groote Eylandt to the east), some Yolngu dialects from north of her land, and is fluent in English.

When I addressed the issue of translating the three terms – nature, observe and practice – I did so expecting that there would be no direct equivalent for any of them and this was the case. The surprise to me was that in Nunggubuyu the three words could all be translated to *junggayi* as they all had related meanings in the language.

When it comes to *nature*, all Nunggubuyu people have relationships with and thus responsibilities towards everything – the plants and the animals, the sea and the land. There are responsibilities that are derived from each person's mother-side and their father-side, and from their grandparents. Older people *observe* younger people, to see whether they are doing anything bad which may harm *junggayi*. "So you don't make a mistake, you have to use things for a purpose and you must sing about the plants and the animals."

People are expected to *practice* the ceremonies – to show others how to perform, the songs and dances, how to use clap sticks and didgeridus. They have to know the different ways of decorating, the designs for painting their bodies and their artefacts. This is all to do with *junggayi*, of being part of nature.

Watson-Verran and Turnbull (1995) provide a similar understanding of the Yolngu word *gurruṯu* in its basic translation, meaning 'relationships' (see Figure 3), but actually "an infinite recursion of a base set of names patterned on family relations enabling everything to be named and related" (p.132). Using *gurruṯu* together with *djalkiri* – stories of the travels and activities of the Creation beings in creating the landscape – Yolngu have been able to assimilate western knowledge. Thus Yolngu knowledge does not see nature-society-knowledge as constituted of distinct and different sorts of things, unlike western science.

Language and indigenous science education

A major issue regarding language with indigenous peoples is the maintenance of their own cultures, languages and knowledges (Battiste & Henderson, 2000; McKinley, 2005), rather than language-culture incommensurability.

However, the following points made by Sutherland and Dennick (2002, pp.4-5) regarding language problems for Canadian First Nations students are comparable for indigenous students elsewhere:

- Cross-linguistic research shows that different meanings in different languages account for many common misconceptions, and there are some suggestions on how language influences science learning. For example, within any language, everyday and scientific usage may be in conflict.
- The means by which students for whom English is a second language convey scientific explanations is influenced by the conventions of discourse in their mother tongue (Lee, Fradd & Sutman, 1995).
- Indigenous languages have a tendency to reinforce the use of analogy or metaphor; thus many objects are referred to through action-based phrases.
- The syntactic order from language to language also differs and may influence the way students provide explanations for various concepts.
- In many Aboriginal languages abstract concepts are specified in relation to actual objects and relationships. 'The abstractions do not occur as words, as subjects for discussion, or as explicit considerations in perception'. (Leavitt 1995: 132).
- The literature supports the view that teaching science in English to some non-Western groups of students does not provide them with equal access to information (e.g. McKinley, McPherson-Waiti & Bell, 1992).

McKinley (2005) indicated that learning science in Maori language in Aotearoa New Zealand runs counter to trends in the other countries. *Kura Kaupapa Maori* (Maori immersion schools) teach in the Maori language so that students learn the language as they learn the subject area, but they have trouble recruiting Maori teachers fluent in the language, with good cultural knowledge and competence in teaching science. She also pointed out that wider scientific community in New Zealand was also turning its interest towards Maori issues, so it is becoming important for science education to help facilitate Maori aspirations for and with the community.

Recommendations to overcome LCI in science for indigenous students

The diversity of situations with science education and indigenous populations makes it difficult to provide any recommendations. In the four countries considered there have been programs undertaken to provide indigenous students with a science education and some research has been undertaken. There has been limited consideration of the language-culture incommensurability in any of these countries. The Aotearoa New Zealand example demonstrates that there is limited enthusiasm in educational authorities for indigenous-based curriculum and pedagogy despite government policies or rhetoric regarding self-determination and sovereignty. Although the consequences of low numbers of indigenous students succeeding in science subjects at secondary and tertiary levels has been of concern, there is also a major concern regarding the maintenance of culture, language and knowledge.

Secondly, indigenous students in these four countries are also found in a diversity of locations varying from urban centres to isolated communities. Often they have lifestyles which parallel western lifestyles although they identify themselves as indigenous; they

speak a variety of English (or French) rather than an indigenous language and probably have a worldview which incorporates elements of their indigenous heritage and the pervasive western worldviews. Others live in communities where they speak their indigenous language but are probably taught in English (or French), where they are exposed to their culture but also to the western world through the media. There have been no studies which indicate particularly how worldview has been modified by such interactions.

It should be acknowledged that there are indigenous peoples found throughout South East Asia who may have limited or no influence on the policies of the nation state pertaining to the education of their children.

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Appendix A

(PowerPoint Presentation Slides)

Language-Culture Incommensurability in Malaysian Science

Loo Seng Piew
Ong Saw Lan
Nagarajan a/l Muniandy

Media of instruction for Malaysian school science

- Before 2003, science taught in 3 languages in primary school – Malay, Chinese, Tamil.
- Beginning 2003, indigenous languages will be phased out and only English used.

LCI in scientific terms in Malaysia

English	Malay	Chinese	Tamil
Dualist	Dualist/Monist	Monist	Monist
nature	alam	zirán 自然	hiyarkai இயற்கை
observe	memerhatikan	guānchá 觀察	uttru arithal உற்றறிதல்
practice	amal	shíyàn 實驗	amal அமல்

English as a Dualist Coded Language

- All conceptual terms in English are essentialist and dualist, i.e., a term is defined by what is not – "It is the exception that makes the rule."
- Essentialist/dualist terms are idealistic, e.g. male-female divide not clearly manifested in nature, exists only as ideal principles.
- E.g., male is not female, female is not male.

Chinese as a Monist Coded Language

- All conceptual terms in Chinese are monist.
- Chinese words are pictographs, each may be a combination of many pictures/concepts.
- In Daoism, dualist opposite concepts exist only as principles, not in reality.
- Ultimate reality is monist oneness – achieved through unity of opposites:

聽 (ting) (listen)

聽 [听] tīng [國] tīng
Ear 耳 learning virtue 惠 with 壬 phonetic. tīng (動) listen (動) heed ⇔ 偏聽, 打聽, 聆聽, 探聽, 竊聽, 重聽, 旁聽, 視聽, 偏聽偏信, 偷聽
• 聽到 tīngdào (動) hear
• 聽話 tīnghuà (動) obey (形) obedient
• 聽見 tīngjiàn (動) hear
• 聽課 tīngkè (動) audit a class (動) attend a class
• 聽命 tīngmìng (動) obey orders
• 聽說 tīngshuō (動) hear (副) reportedly 聽說他生病了. It is said he is sick.
• 聽眾 tīngzhòng (名) audience

ān (安)

安 ĀN
peace, contentment
山 roof
女 woman

bù ān (不安)

山
女 女

Nature

- Nature – realm of the physical objects and biological life forms.
- Nature distinct from the supernatural domain.
- Science focuses only on the study of material objects and natural phenomena.
- Study of spiritual realm and supernatural phenomena domain of religion.

Observe

- Observe – use of the five senses to study natural phenomena.
- Observer and observed are separate (ontological objectivity).
- Observation is objective (free from all bias and values that are personal, cultural, political, religious, etc.) and detached (uninvolved with what is observed).

Practice

- Scientific practice – to put scientific knowledge into use/action.
- Practitioner and instrument/technology/ action/deed are separate.
- Practice is objective (free from all bias and values that are personal, cultural, political, religious, etc.) and detached (emotionally uninvolved with what is observed).

天地 and 自然

- For the Chinese, nature and the supernatural domain are inseparable – monist cosmology.
- No strong tradition of creation in Chinese mythology.
- Legend of Pángǔ implies self-existing cosmos where natural and supernatural domains are one.
- Ancient Daois word for nature is tiāndì (天地), literally means heaven-earth.
- Modern Chinese word is zìrán (自然) = shizen in Japanese.

自然 [ziran = shizen] {nature}

觀察

- For the Chinese, concept of 觀察 (guānchá) is that of participatory observation.
- Observer is not detached from what he/she observes.
- Observer appreciates, cares for what is observed.

觀察 [guancha= kansatsu] {to observe}

實 驗 [shíyàn = jikken]

- 實 驗 (shí yàn)
- 実験 (jikken)
- For the Chinese, 實 驗 is inseparable from the truth and therefore moral action.
- Practitioner follows/merges with the dào (道), and detaches from his/her desires.
- Danger however in merging with false ideology.

行 (Xíng = gyo)

- Díng (行) = gyo in Japanese means repetition of actions until one detaches from self as in religious practice.
- Danger, however, of detachment from self but attachment to false ideology.

Alam

- Malay concept of *alam* rooted in dualist and monist Islamic cosmology.
- Dualism between *alam* and Creator because although *alam* is linked to the Creator, *alam* and the Creator are not one and the same.
- Many concepts of alam but alam concept itself is monist because there is unity of creation under the Islamic principle of *tawhid*.

Tawhid

- The most fundamental concept of Islam – Unity of God.
- Tawhidic principle extended to include

1. Unity of Creation
2. Unity of Humanity
3. Unity of Truth and Knowledge
4. Unity of Life

(Abusullayman, 1989)

Alddunya (Dunia)

بَلْ تُؤْثِرُونَ ٱلْحَيَوٰةَ ٱلدُّنْيَا ﴿١٦﴾

87:16. Bal tu/thiroona alhayata alddunya

Nay! you prefer the life of this world,

Akhirat

وَٱلْـَٔاخِرَةُ خَيْرٌ وَأَبْقَىٰٓ ﴿١٧﴾

87:17. Waal-akhiratu khayrun waabqa.

(while the hereafter is better and more lasting.)

Al-arham (Rahim)

هُوَ ٱلَّذِى يُصَوِّرُكُمْ فِى ٱلْأَرْحَامِ كَيْفَ يَشَآءُ ۚ لَآ إِلَٰهَ إِلَّا هُوَ ٱلْعَزِيزُ ٱلْحَكِيمُ ﴿٦﴾

3:6. Huwa allathee yusawwirukum fee al-arhami kayfa yashao la ilaha illa huwa alAAazeezu alhakeemu

(He it is Who shapes you in the wombs as He likes; there is no god but He, the Mighty, the Wise)

Barzakh

لَعَلِّىٓ أَعْمَلُ صَٰلِحًا فِيمَا تَرَكْتُ كَلَّآ ۚ إِنَّهَا كَلِمَةٌ هُوَ قَآئِلُهَا ۖ وَمِن وَرَآئِهِم بَرْزَخٌ إِلَىٰ يَوْمِ يُبْعَثُونَ ﴿١٠٠﴾

23:100. LaAAallee aAAmalu salihan feema taraktu kalla innaha kalimatun huwa qa-iluha wamin wara-ihim barzakhun ila yawmi yubAAathoona

(Haply I may do good in that which I have left. By no means! it is a (mere) word that he speaks; and before them is a barrier until the day they are raised.)

Alrroohu

يَوْمَ يَقُومُ ٱلرُّوحُ وَٱلْمَلَٰٓئِكَةُ صَفًّا لَّا يَتَكَلَّمُونَ إِلَّا مَنْ أَذِنَ لَهُ ٱلرَّحْمَٰنُ وَقَالَ صَوَابًا ﴿٣٨﴾

78:38. Yawma yaqoomu alrroohu waalmala-ikatu saffan la yatakallamoona illa man athina lahu alrrahmanu waqala sawaban

(The day on which the spirit and the angels shall stand in ranks; they shall not speak except he whom the Beneficent Allah permits and who speaks the right thing.)

Amal

- Unlike dualist coded word 'practice', *amal* is a monist coded word as it is grounded in *iman*, faith.

Eeman (Iman)

وَكَذَٰلِكَ جَعَلْنَٰكُمْ أُمَّةً وَسَطًا لِّتَكُونُوا۟ شُهَدَآءَ عَلَى ٱلنَّاسِ وَيَكُونَ ٱلرَّسُولُ عَلَيْكُمْ شَهِيدًا ۗ وَمَا جَعَلْنَا ٱلْقِبْلَةَ ٱلَّتِى كُنتَ عَلَيْهَآ إِلَّا لِنَعْلَمَ مَن يَتَّبِعُ ٱلرَّسُولَ مِمَّن يَنقَلِبُ عَلَىٰ عَقِبَيْهِ ۚ وَإِن كَانَتْ لَكَبِيرَةً إِلَّا عَلَى ٱلَّذِينَ هَدَى ٱللَّهُ ۗ وَمَا كَانَ ٱللَّهُ لِيُضِيعَ إِيمَٰنَكُمْ ۚ إِنَّ ٱللَّهَ بِٱلنَّاسِ لَرَءُوفٌ رَّحِيمٌ ﴿١٤٣﴾

2:143. Wakathalika jaAAalnakum ummatan wasatan litakoonoo shuhadaa AAala alnnasi wayakoona alrrasoolu AAalaykum shaheedan wama jaAAalna alqiblata allatee kunta AAalayha illa linaAAlama man yattabiAAu alrrasoola mimman yanqalibu AAala AAaqibayhi wa-in kanat lakabeeratan illa AAala allatheena hada Allahu wama kana Allahu liyudeeAAa eemanakum inna Allaha bialnnasi laraoofun raheemun

(And such is the case that We made you an intermediary nation so that you may be a witness against all mankind and this messenger a witness against you. The Qiblah you once observed, We appointed that as well, so that We know who obeys the messenger and who turns round on his heels. It was, indeed, a hard test, except for those whom Allah has guided. It befits not Allah to render futile your faith, for verily Allah is full of kindness and pity towards mankind!)

Amal

قَدْ نَرَىٰ تَقَلُّبَ وَجْهِكَ فِى ٱلسَّمَآءِ ۖ فَلَنُوَلِّيَنَّكَ قِبْلَةً تَرْضَىٰهَا ۚ فَوَلِّ وَجْهَكَ شَطْرَ ٱلْمَسْجِدِ ٱلْحَرَامِ ۚ وَحَيْثُ مَا كُنتُمْ فَوَلُّوا۟ وُجُوهَكُمْ شَطْرَهُۥ ۗ وَإِنَّ ٱلَّذِينَ أُوتُوا۟ ٱلْكِتَٰبَ لَيَعْلَمُونَ أَنَّهُ ٱلْحَقُّ مِن رَّبِّهِمْ ۗ وَمَا ٱللَّهُ بِغَٰفِلٍ عَمَّا يَعْمَلُونَ ﴿١٤٤﴾

2:144. Qad nara taqalluba wajhika fee alssama-i falanuwalliyannaka qiblatan tardaha fawalli wajhaka shatra almasjidi alharami wahaythu ma kuntum fawalloo wujoohakum shatrahu wa-inna allatheena ooteo alkitaba layaAAlamoona annahu alhaqqu min rabbihim wama Allahu bighafilin AAamma yaAAmaloona

(We have observed how you turn your face towards the heavens for guidance (O Mohammed), and We shall surely let you turn towards the Qiblah that you cherish! Turn towards the Hallowed Mosque, and you too (O Muslims), wherever you may be, turn your faces towards it when you pray. Those to whom the Scriptures were given before know well that this Revelation is the truth from their Lord! Allah is not oblivious to what they do!)

Memerhatikan

- In English, observation is dualist coded word observation detached from emotions.
- Malay word formed from root word (*hati*) with double prefix (mem + per) and suffix (kan).

  mem + per (*hati*) + kan = *memerhatikan*
- Hati means the emotional heart.
- Thus, *memerhatikan* is monist coded word meaning "to observe with one's heart".

Hiyarkai

- Unlike English, Tamil is a monist language reflecting pantheistic worldview of Hinduism.
- Tamil word இயற்கை (hiyarkai) combination of

  இயல் + கை
- Pantheism is the belief in the immanent and omnipresent God.
- For Hindus, God is இயற்கை and இயற்கை is God.

Uttru Arithal and Amal

- For Hindus, observation (உற்றறிதல்) and practice (அறல்) are not separable from religious values.

Thank you.

Language-Culture Incommensurability in Thai-Laotian Science

Janchai Yingprayoon

Background Information on Thai-Laotian Culture and Language

Thailand

- Religion: 95% Buddhism – Indian influence
- Race – Local Thai + Oversea Chinese
- Belief: India-China Influences (Indo-china) + Ghost
- Language: Thai language based on Sanskrit developed 900 years ago
- Royal Institute in charge of the translation

Laos

- Religion: 98% Buddhism and 2% Christianity
- Race – Local Laotian + Oversea Chinese +Vietnam
- Belief: India-China Influences (Indo-china) + Ghost
- Language: Laos language based on Sanskrit developed 900 years ago
- Ministry of Education

Religion: 95% Buddhism – Indian influence

Load Buddha's Teachings

- Stop killing
  Experiments with animals ?
- Stop Revenge (Law of Kama)
  You'll get what you have done.

- Wrong Interpretation
  > Passive behavior
- etc.

MIXED CULTURE

- Race – Local Thai + Oversea Chinese
- Belief: India-China Influences (Indo-china)
  + Local beliefs (Ghost) -- Not pure Buddhism

Ghosts/Gods everywhere

Spirit house

Boat ghost

Halloween liked festival

God of Thai Traditional Massage

BELIEFS

Do not step on a book.
>> You will fail.

Do not point at the shooting star.
>>> You'll loose your finger.

Thai language based on Sanskrit , developed 900 years ago

Royal Institute is responsible for the translation.

New Technical terms will be translated using Sanskrit root which are unfamiliar to the Thai People.

This will lead to misunderstandings or misconceptions.

"ท้อง" >>> Pregnancy
>>> Stomach
>>> Abdomen

Common word for common people of all ages.

"ตั้งครรภ์" >>> Pregnancy

Official (high level) vocabulary

Some young kids could not understand.

MISCONCEPTION

More examples

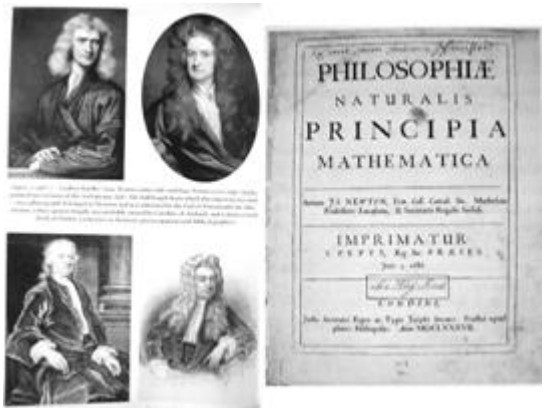
"Resonance"

"สั่นพ้อง" >>> Vibrate synchronously
"กำธร" >>> Vibrate together
"อภินาท" >>> Super acoustic (this may lead to misinterpretation-Super sonic)
"เรโซแนนซ์" >>> Resonance

"Law of Inertia"

1st Law of motion

Cuttings from Newton's tree still grow in Kentish orchards in England; it was a fruit like this one that triggered his eureka moment.



"Inertia"

"เฉื่อย" >>> Slow, inactive or lazy

Experiment on the plane

- There are some other private institutions trying to translate from English to Thai concurrently.
  - Transliterate
  - Usage in daily life (Not popular)
  - Level of language

Western	Thai-Laotian
Dualist	Monist
Nature	ธรรมชาติ Right existence
Observe	สังเกต
Practice	ฝึกหัด

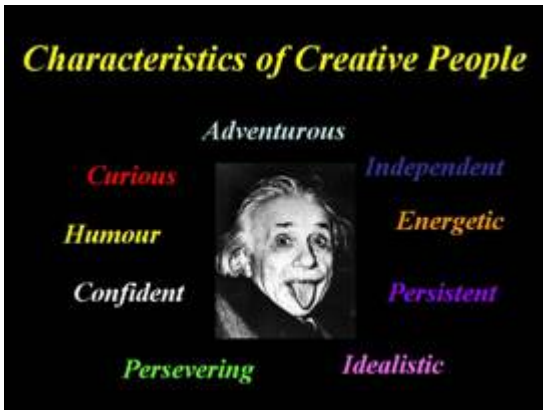
Translation from western technical terms into Thai is not a major problem in learning/teaching science.

Do not look at the meanings of the translated words but the definitions.

A major problem in learning/teaching science in Thailand is that the students do not have an inquiry mind.

They want the teachers to tell them the theory and the results of experiments. They do not want to perform experiments.

They do not have creative ideas and imaginations.



"Imagination is more important than knowledge"

A.Einstein

Einstein's real voice.

"It followed from the special theory of relativity that mass and energy are both but different manifestations of the same thing -- a somewhat unfamiliar conception for the average mind. Furthermore, the equation E is equal to m c-squared, in which energy is put equal to mass, multiplied by the square of the velocity of light, showed that very small amounts of mass may be converted into a very large amount of energy and vice versa. The mass and energy were in fact equivalent, according to the formula mentioned before. This was demonstrated by Cockcroft and Walton in 1932, experimentally."

$E = mc^2$

From the soundtrack of the film, Atomic Physics
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Image © Brown Brothers, Sterling, PA

Table 5
PATENTS REGISTERED IN THE USA BY THE PACIFIC RIM, 1986 AND 1996
Selected countries

	1986	1996
Australia	374	468
Indonesia	3	1
Japan	13 219	23 089
Korea, Rep. of	49	1 496
Malaysia	5	11
New Zealand	52	53
Philippines	1	6
Singapore	4	84
Thailand	3	11
Total	13 710	25 219

Source: CHI research Inc., Haddon Heights, unpublished patent counts supplied to the Centre for Research Policy.

Resource:
World Science Report
UNESCO 2000

Do not turn on car radio too loud!

A good science educational system does not determine who is right,

only who is left.

Thank you
for your attention

Appendix B
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Appendix B