Exploring Factors Contributing to Science Learning via Chinese Language

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Abstract. Numerous psychological and socio-cultural 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. Nevertheless, not much research had been done to illuminate the findings related to factors contributing to science learning using native language of an ethnic group. One of the arguments about possible inhibiting factor for science learning using foreign language is Language-Culture Incommensurability (LCI). 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. This paper aims at analyzing science learning via Chinese language with suggestions also for future research to reduce possible LCI among people who learn science via Chinese language. Literature research and interview findings from case study will be reported to explore the various enabling and inhibiting factors affecting students' science learning, thus identifying possible causes for LCI arising from the direct translations of scientific terms in the English language into equivalent terms in indigenous language. Culture and language are closely related, the former is the consequence of the latter and vice-versa. Each Chinese word carries meaning by itself which poses as strength and weakness in the learning of science. If cultural difference is the inhibiting factor in learning science, to the Malaysian Chinese as discussed predominantly in this paper, the enabling factor is the ability to master English, the language of Western science, and their mother tongue, the Chinese.

***Key words**: Language-Culture Incommensurability (LCI), intercultural communication, problems of translation, science learning, Chinese language, psychology, socio-cultural learning theories.*

Introduction and Aims of Study

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. Numerous psychology of learning and socio-cultural 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. Nevertheless, not much research could be found to illuminate the findings related to factors contributing to science learning using native language of an ethnic group. Kawasaki (2002) 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 exploring how various philosophical, socio-cultural and psychological factors influence or impede learning via literature research. At the same time, the authors also attempt to analyse the possible sources of misunderstandings and Language-Culture Incommensurability (LCI) (Kawasaki 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 be reported on the inhibiting and enabling factor in learning science via Chinese language.

Research Problems, Methodology and Focus or Background of Study

Research problems and focus or background of study

As stated earlier, there was not much research conducted to illuminate the findings related to factors contributing to science learning using native language of an ethnic group. The following research problems are identified in this study:

- What are the differences between traditional Chinese understandings of the world compare to the Western scientific worldview?
- What are the various enabling and inhibiting factors affecting students' science learning via Chinese language?
- What are the possible causes for and how to avoid Language-Culture Incommensurability (LCI) arising from the direct translations of scientific terms in the

English language into equivalent terms in indigenous language?

Methodology for Data Collection

The data collection method for this study will be mainly through literature research to trace the philosophical background of Chinese worldview in science learning. The various psychological and socio-cultural factors that may cause LCI will also be analyzed from literature review. In addition, interviews will be conducted with various professionals experiencing science learning via Chinese as their own mother tongue or as foreign language to explore their views on inhibiting and enabling factors for culturally influenced science learning.

Analysing Science Learning via Chinese Language from Philosophical, Psychological and Socio-cultural Perspectives through Literature Research

This section dwells on the philosophical perspectives of subjectivity versus objectivity. The next section will discuss the psychological and socio-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" (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' (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. "*Qi*"(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 *Yang*́ 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 are 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*ˋ (heaven and earth), *kui*ˇ 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

(1) 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.

(2) 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.

(3) 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. (Appendix 1)

(4) 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 Tongˋ 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. (Appendix 2)

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.

Socio-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). 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 (Brislin 1993). 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; 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 family members and peer groups, with input from formal and non-formal learning contexts are also important factors from sociological viewpoint.

Learning viewed from 'social learning' or 'social constructivists' theories focuses on learners' prior knowledge and how they construct 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 use of tools and artifacts e.g. books in mediating learning] and with *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 where learning activities take place (Salomon 1997).

From the socio-cultural theoretical perspectives, learning is viewed as a social and cultural activity mediated by social and environmental factors around the learners. Thus, modes of communication are socio-culturally shaped (Young 1996). Cultural differences would therefore become potential sources of miscommunication as participants make sense of their interactions by using different interpretative frameworks (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 confusion between learned items. When competing information is stored in short-term memory, the *resulting crowding* will affect a person's memory for particular items. E.g., 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 numerous problems for a person to master a lot 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 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. But studying French, followed by studying psychology, interferes with or inhibits the recall of French, i.e. retroactive inhibition (Lefton 1991).

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 "cheˋ" (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 (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.

Analysis and 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 with many Malay students, National Type Chinese Primary School where students are predominantly Chinese and National Type Indian Primary School with mainly Indian students. Science and Mathematics were taught in students' mother tongue in these three types of schools prior to 2003. These primary schools display characteristic influenced by the culture of the majority ethnic group in school though 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 opinions 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 graduated 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....*

(Engineer 1 graduated from Taiwan, interviewed in October 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 ....*

(Engineer 2 graduated from Taiwan, interviewed in November 2005)

It is apparent that the use of mother tongue to teach 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 language or its translation, the English equivalent of terminologies used is introduced to 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. It may not be feasible as it may not be the lingua-franca of the local community,. The inhibiting factor (that cannot be taken lightly) in this case is the inability to master English language and the conflict that might arise since language is closely related to culture, the English culture might be incommensurable to local culture.

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 graduated from Taiwan shed some light on it,

> *My personal opinions are.... Chinese history showed that most 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., Meng Tzeˇ, Laoˇ Tzeˇ, Confucians, etc.), and not so much using the knowledge in science and technology (S&T)....At later stages, some Chinese went overseas (e.g. Russia, Europe, Japan, etc.) to study S&T....As there was then a standardized and established W-Science and S.I. units to refer, so ....presumably.... most of the teaching in S&T in educational institutions will then be based on the knowledge and terminologies or W-Scientific worldview ....I guess....*

(Engineer 1 graduated from Taiwan, interviewed in October 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 become proficient in both Chinese and English languages 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 or references in English....But I'm glad that I am Chinese educated as there are so many rich scientific knowledge to discover that are recorded in references written in Chinese language, e.g. Qi Gong, herbal medicine…many more…*

(Engineer 3 graduated from Singapore, November 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 / Maths educators, October 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`, Qi` Qi` Si` Shí Jiuˇ", etc. It sounds easier to remember than using English translated calculations such as "one times one equals to two, seven times seven equals to fourty 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, interviewed in November 2005)

Having the advantage of being bilingual (Chinese and English) has facilitated the educators interviewed above to master science and maths. The enabling factor in this context is mastery in both the language of W-science and own mother tongue. Perhaps this poses as a possible solution to the issue of medium of instruction in teaching science and mathematics to the Malaysian, also 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 W-science worldview and their own culturally biased worldview, i.e. towards the restoration of subjectivity as proposed by Kawasaki (2005) and 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 science teaching or development of science and technology in China or the world, because the philosophy of traditional Chinese has so far confined itself to specific disciplines e.g.Chinese medicine, *qigong, fenshui, astrology,* etc. The science that has developed and established itself into a formidable discipline is that of the western science that 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, science teaching to Chinese need to take this traditional Chinese view into consideration lest LCI proliferate among the students and causes misconceptions that can be difficult to disentangle. The Chinese language has its strength in science learning 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 that is difficult to unlearn. The inhibiting factor in learning W-science is the cultural difference between west and the local community (as discussed here as 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 are 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 science teaching via W-science worldview with illustrations related to the students' diversified socio-cultural background and language used.
- Identify socio-cultural factors contributing to excellent performance in science and mathematics education via native language, such as those reported in international studies like TIMSS.
- A more comprehensive study to trace the historical development of science education 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 in science.
- An experimental study to compare science learning 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 learning process among these groups can be studied in a more thorough manner.

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References

1. American Association for the Advancement of Science (AAAS) 1993, Benchmarks for Science Literacy-project 2061, New York, Oxford UP.
2. Austin, T 1998, Cross-cultural pragmatics – Building in analysis of communication across cultures and languages: Examples from Japanese, Foreign Language Annals, 31(3), 326-346.
3. Brislin, RW 1993, Understanding culture's influence on behaviour, NY, Harcourt Brace College.
4. Cortazzi, M 1990, Cultural and educational expectations in the language classroom. In Harrison, B (Ed.), Culture and the language classroom (pp.54-65). Hong Kong: Modern English Publications and the British Council.
5. Craig, BA 1995, Boundary discourse and the authority of knowledge in the second-language classroom: A social constructionist approach. In Alatis, JE et al., (Eds.), Georgetown University round table on languages and linguistics, 1995 (pp.40-54), Washington DC: Georgetown UP.
6. Edge, J 1996, Cross-cultural paradoxes in a profession of values, TESOL Quarterly, 30(1), 9-30.
7. Ellsworth, E, 1997, Teaching positions: Difference, pedagogy, and the power of address, New York, Teachers College Press.
8. Fickel, LH 2002, "Quality Professional Development: Suggestions" in The Educational Forum by Kappa Delta Pi, Vol. 67, Fall 2002, pp.47-54.
9. Gere & Timoshenko 1977, Mechanics of Materials. Second Edition. Taipei: "Kan Thai" Science and Technology Sdn Bhd.
10. Gudykunst, WB 1994, Bridging differences: Effective intergroup communication (2nd ed.), London, Sage Publications.
11. Johnson, YLL 2001, A woman's Qigong Guide – Empowerment Through Movement, Diet, and Herbs, Boston, YMAA Publication.
12. Kawasaki, K 2002, "A Cross-Cultural Comparison of English and Japanese Linguistic Assumptions Influencing Pupils' Learning of Science", Canadian and International Education, Vol.31, No.1, June 2002, 19-51.
13. Kawasaki, K 2005, "Towards Worldview Education beyond Language-Culture Incommensurability". Keynote paper presented in SACAS Conference-Workshop on Southeast Asian and Japanese Cultural Influences on the Understanding of Scientific Concepts. 3-5 October 2005, RECSAM.
14. Lefton, LA 1991, Psychology, Fourth Edition, Boston, Allyn and Bacon.
15. Li, MS 1999 Discourse and Culture of Learning: Communication of Challenges, Bundoora, VIC 3083, Graduate School of Education, La Trobe University. [Refer http://www.aare.edu.au/99pap/lim99015.htm]
16. Loo, SP 2005, "Philosophy, cosmology and language-culture incommensurability in science", Paper presented in SACAS Conference-Workshop on Southeast Asian and Japanese Cultural Influences on the Understanding of Scientific Concepts, 3-5 October 2005, RECSAM.
17. McConnell, D 2000, Implementing Computer Supported Cooperative Learning (CSCL), London: Kogan Page Limited.
18. Popkewitz, TS 1987, Ideology and social formation in teacher education. In Popkewitz, TS (Ed.), Critical studies in teacher education: Its folklore, theory and practice (pp.2-33), The Falmer Press.
19. Pusat Perkembangan Kurikulum Malaysia. (1999). Istilah Mata Pelajaran KBSR dalam Bahasa Cina. Kementerian Pendidikan Malaysia
20. Ryan, M 1998, Cultural knowledge and foreign language teachers: A case study of native speaker of English and a native speaker of Spanish. Language, Culture and Curriculum, 11(2), 135-153.
21. Salomon, G 1997, Novel Constructivist Learning Environments and Novel Technologies: Some issues to be concerned. Keynote Address at the EARLI Conference, 23-26 August, 1997.
22. Scollon, R & Scollon, SW 1995. Intercultural communication: A discourse approach, Oxford, Blackwell.
23. Whorf, BL 1959, Language, thought, and reality, New York, John Wiley and Sons.
24. Young, R 1996, Intercultural Communication. Pragmatics, genealogy, deconstruction, Adelaide, Multilingual Matters Ltd.

Khar Thoe Ng ir Soo Boon Ng

Faktorių, padedančių studijuoti gamtos mokslus kinų kalba, tyrimas

Santrauka

Ne viena psichologinė ir sociokultūrinė mokymosi teorija buvo naudojama norint paaiškinti faktorius, įtakojančius asmens kalbos mokėjimą ir tam tikros disciplinos, tokios kaip gamtos mokslai, mokymąsi. Nepaisant to, nebuvo atlikta išsamių tyrimų siekiant atskleisti faktorius, padedančius mokytis gamtos mokslus, naudojant etninės grupės gimtąją kalbą. Vienas iš argumentų apie galimą suvaržymą mokantis gamtos mokslų užsienio kalba yra kalbos kultūros skirtumai. Toks reiškinys moksle yra tiesioginė Vakarų etninio gamtos mokslų mokymo praktikos pasekmė neatsižvelgiant į sociokultūrinę studentų kilmę. Vakarų pasaulėžiūra labai skiriasi nuo tradicinio kinų filosofinio mąstymo apie gyvybės kilmę ir ryšį tarp žmogaus ir jo gyvenamosios aplinkos; tai yra objektyvumo lyginant su subjektyvumu problema. Studijuojant gamtos mokslus, kinų studentams įtakos turi šio ryšio kultūrinis suvokimas, atsirandantis dėl kalbos kultūros skirtingumo. Šis straipsnis analizuoja gamtos mokslų mokymąsi kinų kalba ir pateikia pasiūlymus būsimiems tyrimams, siekiant sumažinti galimus kalbos kultūros skirtumus tarp žmonių, kurie mokosi gamtos mokslų kinų kalba. Literatūros šaltinių analizė ir socialinio tyrimo metu atliktos apklausos rezultatai padeda ištirti įvairius teigiamus ir neigiamus faktorius, įtakojančius studentų gamtos mokslų mokymąsi. Taip pat nurodomos galimos priežastys dėl ko gali atsirasti kalbos kultūros skirtumai, kai mokslo terminai yra tiesiogiai verčiami iš anglų kalbos į ekvivalentiškus vietinės kalbos terminus. Kultūra ir kalba yra artimai susiję, pirmoji yra antrosios pasekmė ir atvirkščiai. Kiekvienas kinų kalbos žodis turi savo prasmę, kuri padeda ir trukdo studijuojant gamtos mokslus. Jei kultūriniai skirtumai yra faktorius, kuris trukdo Malaizijoje gyvenantiems kinų tautybės studentams mokytis gamtos mokslus (apie ką yra diskutuojama šiame straipsnyje), tai patariama gerai išmokti anglų kalbą, t.y. Vakarų mokslo kalbą, o taip pat savo gimtąją kinų kalbą.

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APPENDIXES

APPENDIX 1

Table 1: Examples of scientific terms generally used in science curriculum and its equivalent terms in Chinese language

Scientific terms in English language	***Scientific terms in Chinese language***	
	Chinese terms	**Meaning interpreted literally**
weight	*Zhong` Liang`* (**重量**)	*Zhong`* is heavy, *Liang`* is amount, both terms 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.
Solid	*Gu` Thi˘* (**固体**)	*Gu`* is fixed, doesn't change shape, *Thi˘* is body, put together it means a body which is fixed and doesn't change shape.
Reflection	*Fan˘ She`* (**反射**)	*Fan˘* is the opposite, *She`* is shoot, put together it gives an impression of something shooting in the opposite direction.
Manipulated or 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.

APPENDIX 2

Table 2: Examples of scientific terms in Chinese language which might be the cause of misconception

English scientific terms	***Scientific terms in Chinese language***	
	Terminology	**Meaning and possible LCI**
Flowering plant	*Xian˘ Hua Zhí Wù* (**显花植物**)	*Xian˘* is seen, *Hua* is flower, *Zhí Wù* is plant, put together it is plant where flower can be seen. *Yin˘* is hidden, cannot be seen, *Hua* is flower, *Zhí Wù* is plant, put together it is plant where flower is hidden. In some textbook, *Yin˘ Hua Zhí Wù* is used to also include non-flowering plant, but literally translated, *Yin˘ Hua* is only where the flower is hidden and not that there is no flower. In some textbook, another term *Wú Hua Zhí Wù* (**无花植物**) that is plant without flower is used. Some Chinese text book said that there are three categories of plant, *Xian˘ Hua Zhí Wù*, *Yin˘ Hua Zhí Wù* and *Wú Hua Zhí Wù*, it is quite confusing especially for primary school children
Non-flowering plant	*Yin˘ Hua Zhí Wù* (**隐花植物**)	
Hypothesis	*Jia˘ She`* (**假设**)	Literally *Tui Duan`* can mean deduce and *Jia˘ 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**)	

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