How to Conceptualize "Culture"

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Summary: Formulating an implicit definition of "culture," this paper synthesizes two different facets in science education research within the framework of structural linguistics. One is science education research with an emphasis on each individual pupil's learning behaviour: border-crossing and collateral-learning, typically.   The other is one with an emphasis on pupils' cultural setting for learning: the present author's stance that science education should be conducted as foreign language education.   Moreover, this paper insists that science teachers should be aware of their cultural comparatist role in which they become able to realize their own culture.   This is an epistemological reflection on cultural setting for science education.   Taking such an epistemological reflection into consideration, science teachers will give pupils an appropriate assist to cross borders and lean collaterally, and will assure pupils of preserving their cultural identity in science education.

Memo:

The tension between an individual and the society to which he or she belongs appears only in a synchronic perspective; it cannot be considered in a diachronic perspective.

INTRODUCTION

Importance of cross-cultural perspective to science education research is increasing rapidly as science education researchers are getting global views of various cultures. In many of cultures, people do not take Western scientific worldview for granted; the Western scientific worldview is peculiar to the Western civilization. This results in various types of science education because in a society people conduct science education on the basis of an institutionalized or socialized view of Western science, not on the basis of Western science as such (Kawasaki, 1996). Naturally, the institutionalized view of Western science depends solely on a culture concerned. Thus, each society has its rationale for science education according to what the society regards Western science as. In other words, the rationale reflects what the society expects from science education. Therefore, science teachers need the cross-cultural perspective because science teachers have to grasp pupils' cultural setting for learning in order to improve in teaching.

Since the institutionalized view of Western science is ultimately embodied in science teachers, it is essential for them to clarify the reason why such a rationale is formulated. This means that science teachers should understand a culture by which they live actually. For this purpose, if science teachers share the same culture with their pupils, they have to assume the same stance on the culture as comparatists do. Because comparatists conduct their study on a foreign culture in order to understand their own culture in contrast to the foreign culture. This self-referential consideration is exactly similar to a basic part of philosophy. Science educators should perform their comparatist or philosopher part in science education research or teaching.

When science educators consider their own culture in their epistemological reflection, it is imperative for them to consider how to conceptualize "culture" and what the "culture" means in science education research and teaching. A typical example of defining it is: culture is a whole way of life (Barnard, 1973, p. 614). All definitions Aikenhead (1996) adduces in relation to "border-crossing" have the same form as Barnard's: Culture is "something." This form of definition is appropriately called explicit or positive. In a positive definition, knowledge about a definiendum, i.e., that which is defined, is unnecessary in principle for grasping its definiens, i.e., the phrase that states the meaning. The definiendum and definiens appear independent of each other.

On the contrary, in definitions formulated in an implicit or negative manner, both are

interrelated (Kawasaki, 1996; 1999).   In the negative manner, a definition focuses on relationship between its definiendum and definiens (Blanche, 1973, p. 168).   According to the reference frame of structural linguistics, I will give negative definitions of "culture" in two cases: border-crossing and collateral-learning in Aikenhead & Jegede (1999) and my proposal that science educators should conduct science education as foreign language education (Kawasaki 1996), referred as "as-foreign-language" hereafter.   I will reveal that "culture" conceptualized in Aikenhead & Jegede (1999) and that in "as-foreign-language" are complementary to each other, and will argue that the negative definition of "culture" makes it possible for science educators to conduct self-referential consideration easier.

DEFINITION IN NEGATIVE MANNER

The following explanation of negative definition is based on both anti-essentialism and anti-realism, and these features are shared with social constructionism (Burr, 1995, pp.5-6). The positive definition tries to describe the essence and reality of a definiendum concerned.

1) Weather Chart Metaphor

A weather chart metaphor well illustrates how to conceptualize and demarcate a linguistic sign, i.e., its concept in the negative manner (Kawasaki, 1997).   This is essentially the same explanation as given in structural linguistics.   When a meteorologist makes a weather chart, isobars are usually drawn on the basis of data as to atmospheric pressure at a specific time. As he or she draws the isobars in detail, a low pressure, for instance, turns out to be a meteorological unit gradually; at the same time, other high and low pressures that surround this low pressure also appear as units of the same kind.   In order to realize this low pressure, the meteorologist needs the other high and low pressures that surround the low pressure concerned.   In other words, the meaning space of the low pressure encompasses the whole space of the chart.   In the same way, each of other high and low pressures encompass.

This interrelationship between the meteorological units in the weather chart is compared to an interrelationship of linguistic signs in a specific language.   A word is a meteorological unit, and a language to which the word belongs is the whole space of the weather chart

> 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

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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* constructs the meaning space of *green*. To construct the meaning space is to establish the differentiating relationship between colours, in this case.

Therefore, if the bundle of "nots" changes, the meaning space of *green* also changes. For instance, imagine a culture where people recognize seven colours in rainbows:　red, orange, yellow, *green*, blue, indigo and purple.　And also imagine another culture 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 show exactly the same spectral range, to use the spectroscopic term in physics, because the two bundles of "nots" differ from each other.　In other words, meaning spaces of the two types of *green* are not identical:　The linguistic values of *green* differ from each other.　They show cultural incommensurability.　This stems from the fact that two cultures articulate the rainbow colours from different viewpoints.

Moreover, it should be revealed that difference in tone of each colour is disregarded in both types of colour articulation in rainbows.　The same thing can be said of the articulation of meteorological units.　In drawing the isobars, he or she naturally overlooks micro-meteorological phenomena; for instance, a whirl is overlooked in comparison to a typhoon in such a case.　The meteorologist has unavoidably made this implicit presupposition. Conversely, being interesting in the whirl, the meteorologist describes its micro-meteorological structure without considering the larger structure of the typhoon.　Generally, articulation of a concept would be impossible without disregarding larger or smaller structure:　the word "green" only shows differences from other colours, and disregards difference between "emerald green" and "malachite green."

In the weather chart, the appearance of this low pressure means not to find something that has been already present but to create an object of consideration and observation from the viewpoint of air pressure.　If the meteorologist draws isothermal lines on the same chart, for instance, he or she realizes another atmospheric structure.　There, air masses with various

degrees of temperature are articulated from a different viewpoint from that of air pressure. This means that the meteorologist creates another system of objects of consideration and observation from the viewpoint of air temperature.

Now, there are two types of weather chart drawn from the two different viewpoints. The difference between the two types of weather chart is compared to difference in articulation of linguistic signs or concepts between languages, and then difference between cultures. Depending on a viewpoint, each language articulates its own system of objects of consideration, i.e., a system of words. In articulating linguistic units or objects of consideration, de Saussure insists that "far from it being the object that antedates the viewpoint, it would seem that it is the viewpoint that creates the object" (de Saussure, 1966, p.8).

Therefore, a viewpoint results in its linguistic articulation in which linguistic signs turn out to be objects of recognition and consideration. The following describes the recognizing role of language.

> Man cannot come into direct contact with the elements composing his 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. (Suzuki, 1993, p. 40)

In a usual linguistic community, people share the viewpoint through learning of the language, and take their viewpoint for granted. However, when they encounter foreign language people, their conviction that only their viewpoint is natural needs to be explained for mutual understanding. At the same time, the foreign language people need to explain their congruent conviction on their own viewpoint; if not, as a result of their failure in mutual understanding, linguistic (i.e., cultural) governing or submission must be yielded. Obviously, this intellectual process for mutual understanding involves cultural relativization to each other.

2) To Conceptualize "Culture"

There are too many positive definitions of "culture" than researchers can manage (e.g., Barnard 1973, p. 614; Aikenhead, 1996). On the contrary, defining "culture" in the negative manner gives another perspective of cross-cultural studies that can reduce cultural bias as weak

as possible because this procedure naturally introduces the viewpoint of culture-relativism. The way to conceptualize "culture" as an object of consideration is well compared to how to create the meteorological units from a specific viewpoint in the weather chart metaphor. Constructing a bundle of "not-cultures," a specific culture is thought to be an object of consideration. Elucidation of the objective culture needs three issues to be discussed: 1) the viewpoint to articulate this culture as an object of consideration, 2) cultures that surround this objective culture and 3) super- and/or sub-cultures overlooked in the perception of cultures concerned. The three issues closely relate to each other, of course, and the negative definition of the culture is equivalent to a description of these three issues.

For example, I formulate the negative definition of the Japanese culture by describing how the Japanese language is articulated. This example effectively explains how to conceptualize "culture" from the viewpoint of structuralism because "the master discipline of structuralism, to which all its practitioners constantly revert, is linguistics" (Caws 1973, p.323). First, the viewpoint to articulate "the Japanese language" is my awareness that I use the Japanese language. The awareness forms the core of my feeling that I belong to the linguistic or cultural community of Japan. Second, languages that surround the Japanese language are: the English, German, Swahili, Chinese, Korean, etc., languages, all of which I can differentiate from the Japanese language. Third, in this articulation, I have naturally overlooked difference between dialects in each language, in particular the Japanese language. From another viewpoint to articulate my dialect as an object of consideration in the Japanese language, another type of difference between personal habits in speaking is ignored.

Of course such a viewpoint is not uniquely established, but rather arbitrarily established. In other words, criteria to differentiate an objective language from others are formulated arbitrarily. Because of this arbitrariness it is probable that persons who speak different dialects classified under a single name of language, e.g., the Chinese language, cannot make oral communication with each other (Fisher, 1999, p.131). These speaking systems might be more than just dialects. Conversely, there may be languages that are properly considered as dialects in a single language. Actually, Fisher (1999, p. 124) points out that Scandinavian languages can be regarded as Scandinavian dialects. A viewpoint to distinguish between the English and Japanese languages is not identical to another to distinguish between Scandinavian languages. This arbitrariness in distinction between languages depends basically on individuals' awareness of using the same language.

Depending on individuals' awareness of living by the same culture, a conception "culture" involves the same arbitrariness as "language." For example, there may be a case where a distinction between Western scientific and Christian worldviews is less significant when a viewpoint to distinguish the West from the non-West is established. For instance, since Japanese people share neither Western nor Christian viewpoints, "conflict" between science and religion in the Western history is less significant to the Japanese people than to Western people.

From the viewpoint of science education conducted in Japan, an immediately relevant language is the Japanese language, i.e., the Japanese culture, and the most significant factor in a linguistic bundle of "nots" is the English language, i.e., the English culture. However, if science educators consider only the English culture in the perspective of science education, the notion "the English culture" improperly restricts the notion "Western science." Because of that reason, science education in Japan requires a broader notion of culture than "the English culture," and the culture includes the cultures where Western science has been developed: the Western culture. In coining this conception, difference between European cultures can be disregarded, and this is justifiable by an explicit description of a procedure for formulating the Western culture in the negative manner.

The conception "Western culture" is identical with Whorf's notion "SAE (Standard Average European)" which lumps the following languages into one group: English, French, German and other European languages with the possible (but doubtful) exception of Balto-Slavic and non-Indo-European (Whorf, 1959, p. 138). He creates this linguistic group as an object of consideration in his linguistic research on American First Nations' languages in comparing to European languages. To set an American First Nation language against "SAE" is exactly a similar linguistic situation to the Japanese language surrounded by "SAE." The Western culture corresponding to "SAE" is acceptable as the most significant factor to science education in Japan: the most significant member of the culture bundle of "nots." The viewpoint established in this procedure is applicable to science education conducted in non-Western countries with proper linguistic or cultural interpretation.

"CULTURE" IN VARIOUS CASES

In this section, I describe "culture" 1) in "cultural border-crossing" and

"collateral-learning" (Aikenhead & Jegede, 1999), and 2) in "as-foreign-language" (Kawasaki, 1996).   And 3) I discuss relationship between two types of "culture" in 1) and 2).

1) "Culture" in Cultural Border-Crossing and Collateral-Learning

Aikenhead focuses on how students move between their everyday life-world and the world of school science, and Jegede does how students deal with cognitive conflicts between those two worlds (Aikenhead & Jegede 1999).   There, everyday life-world and the world of school science are considered to be subculture.   According to the negative manner of definition, the relationship between the subcultures is: pupils' everyday life-world is carved in relief against the world of school science, and vice versa.   With taking account of the fact that the content of science education belongs to the Western culture in principle, I point out that there are two types of the border to cross: one case that the everyday life-world belongs to the Western culture, and the other case that it belongs to the non-Western culture. Obviously, the distinction between the two types is made from a viewpoint of science education in the non-West.

On one hand, pupils cross the border of the first type between subcultures belonging to the same culture, the Western culture.   On other hand, regarding the border of the second type, pupils have to cross a borer between the Western and non-Western cultures, and then they arrive at the world of school science.   The first type of border-crossing must be easier than the second.   In the first type of border crossing, pupils really experience subcultural identity disruption, but their cultural identity crisis can be avoided.   In the second type, however, they are inevitably forced to experience cultural identity crisis.   This is a paraphrase of "the degree of cultural difference that students perceive between their life-world and their science classroom" (Aikenhead & Jegede, 1999).   For instance, since Japanese pupils have to cross the border of the second type, they need much more effort to accomplish borer-crossing and collateral-learning than Western pupils.

According to "culture" conceptualized in Aikenhead & Jegede (1999), the research has a distinctive feature.   Describing ingredients for successful border-crossing and collateral-learning, the authors take a keen interest in how to assist students' border-crossing and collateral-learning.   This means that the authors focus on each individual pupil's experience of learning in science lessons rather than their cultural setting in which pupils perform their thought and behaviour.   My present supposition is strengthened by the fact that

the authors frequently refer to pupils' names, namely Fatima, Ann, Melanie, Art, Brent, Todd and Ian. In cultural border-crossing and collateral-learning, each individual student challenges to cross the border and learns collaterally; teachers are supposed to perform educational part in assisting pupils to accomplish their crossing and learning.

2) "Culture" in Science Education as "Foreign-Language-Education"

On the contrary, I do not refer to pupils' actual names in my research developing the idea "as-foreign-language." This exhibits a striking contrast to the research of Aikenhead & Jegede (1999). In my research of "as-foreign-language," pupils are supposed to be under the influence of their cultural setting as social norms, which are embodied ultimately in science teachers. In "as-foreign-language," the Japanese language as a non-SAE language is set against SAE languages in the perspective of science education. Linguistic differences between SAE languages are less significant to my viewpoint. This is equivalent to the point that the Japanese culture is set against the Western culture, and this viewpoint disregards differences in culture between the Western cultures.

One of typical issues of the "as-foreign-language" is translation of Western scientific terms into the Japanese langauge because pupils are forced to cross a border of the second type between the Japanese language and the SAE language, typically the English language. In order to understand pupils' linguistic situation, I would like to add the following sentence to "to learn science is to acquire the culture of science" (Aikenhead & Jegede 1999): to learn the culture of Western science is to acquire the language of Western science. A good example is provided in Reeves' experience in a quotation given by Aikenhead & Jegede (1999) from CBC (1995). For readers' convenience, I make a copy of it at the end of this paper[1]. Clearly, the authors made the quotation to illuminate Reeves' poetic heart that collided with his scientific mind. His experience admitted of no doubt, and his border crossing followed his feeling of the collision.

However, Reeves' experience is irrelevant to the Japanese language milieu. If he had been inculcated in the Japanese culture, he would not have experienced such a border-crossing. The English term "to contemplate" is a key to explain this. The English word "to contemplate" strongly implies the use of the sense of sight, and the English language differentiates it from "to observe." When Reeves contemplated "this calm ocean, gloriously tinted by the setting sun," he was not observing it at all. Although the English term "to

observe" is translated into the Japanese term "kansatsu" for science education, Kawasaki (1999) reveals that the most possible English translation of "kansatsu" must be "to contemplate." This means that the Japanese people do not make a clear distinction between "to contemplate" and "to observe" as Reeves did. The Japanese people do not articulate the two kinds of activity differently; actually, they have refused to observe the outside world according to the Japanese cultural tradition (Kawasaki, 1999). Hence, it is not probable that a person inculcated in the Japanese language share the same experience with Reeves because Reeves' experience was based on that distinction between "to contemplate" and "to observe."

In Japan, science teachers as well as researchers have accepted this translation since Japan began to conduct science education in late nineteenth century. There must be a certain relationship between this translation and the Japanese institutionalized view of Western science, the view which does not distinguish between "to contemplate" and "to observe." Thus, what Japanese pupils learn in science classes is not the same as English pupils learn. In the linguistic milieu of Japan, it must be difficult for science teachers to be aware of the difference in what pupils learn because most people in a linguistic community are inclined to take their linguistic phenomena for granted.

Only the comparatist stance on pupils' linguistic or cultural setting can disclose this difference. In comparatist investigation, I stress in the first places on the educational setting affecting pupils' learning behaviour, and disregard difference in learning behaviour between individual pupils. Since my chief objective is to liberate science educators from the cultural pressure generated in their conducting science education, "as-foreign-language" offers to have science educators assume the comparatist stance, which leads them to an epistemological reflection. Their epistemological reflection must relieve the pressure, in the same way that mental patients essentially need to realize their mental illness by themselves in order to be cured. Only when science educators liberate themselves from the cultural pressure in Japan, they will be able to understand Western science in a relativist perspective and deepen mutual understandings between the West and Japan.

3) Relationship

In this subsection, by means of a pair of juxtaposition of structural linguistics terms, I distinguish the four types of "culture," two of which correspond to the "culture" conceptualized in Aikenhead & Jegede (1999) and in Kawasaki (1996; 1999). The first

juxtaposition is to set social norms against each individual behaviour. The second juxtapose a synchronic perspective against a diachronic perspective. The combination of the pair of juxtaposition differentiates four viewpoints to consider a specific linguistic or cultural phenomenon.

In the following, "langue" stands for a system of linguistic norms and "parole" does speech act. Since "langue" can be interpreted as a system of social norms (i.e., culture in a social perspective), "parole" means each individual's behaviour under the influence of the system of social norms (i.e., culture in individual perspective). Distinguishing between "langue" and "parole" strictly, structural linguistics well explains this point that they are complementary.

> *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. *La langue* is what the individual assimilates when he learns a language, a set of forms…. (Culler, 1988, p.29)

Every language, culture, dialect and subculture show these two facets: "langue" and "parole." People behave under the influence of the social norms, and their behaviours change the social norms conversely.

The language as a system of forms or norms cannot be experienced because it is only in individual's mind. For example, no one can indicate "the English language" for two reasons. First, the notion "the English language" is abstracted from various dialects belonging to this language and from personal speech acts of habit. Second, it is impossible to make a complete description of "the English language" as a social system of norms in an explicit form, but every individual can believe in "the English language" defined in the negative manner. According to this system of norms, he or she speaks, hears, writes and reads "the English language." In other words, he or she conducts "parole." In the same way, each individual is able to perform his or her "parole" of cultural behaviour according to "langue" facet of the culture to which he or she belongs.

To use the structural linguistic terms, border-crossing and collateral-learning pay attention mainly to "parole," and "as-foreign-language" does to "langue." On one hand, since the research in border-crossing and collateral-learning investigate each individual pupil's change

in "parole," the research makes diachronic descriptions on each pupil and basically includes developmental psychology.   On the other hand, the research in "as-foreign-language" is made in a synchronic perspective, i.e., cross-cultural, and oriented to cultural anthropology.   This investigates pupils' "langue," i.e., the educational setting for each pupil's change in "parole," and makes it possible for science educators to classify pupils' change in "parole" according to their "langue."   The classification will afford the most appropriate teachers' assistance in each pupil's crossing and learning.

Piaget is one of distinguished scholars who investigate children in a diachronic perspective.   It is well known that Piaget's contemporaries as well as himself shared an impression that "structuralism" had no interest in diachronic descriptions:

> 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, p. 12)

Under the considerable influence of Piaget, few science educators have paid attention to the dynamism of structuralism.   This is naturally excusable because science educators' chief concern must be in pupils' change in "parole."   Their research naturally consists of diachronic descriptions on each individual pupil.

However, the impression Piaget formed since "a structuralist explosion" in the nineteen-fifties in France (Caws, 1973, p. 324) is a slight misunderstanding.   Actually, an assertion made by de Saussure was: "diachronic identity depends on a series of synchronic identities" (Culler, 1988, p. 39).   The weather chart metaphor well explains this.   If the meteorologist tries to make a diachronic description on the specific low pressure, he or she needs a series of weather charts concerned, for the reason that the low pressure is created in each weather chart as discussed above.   In principle, structuralism never denies any diachronic descriptions on linguistic (i.e., cultural) phenomena.   Structuralism that allows diachronic descriptions is properly called "post-structuralism" (Burr, 1995, p.39), but post-structuralism might originate from what those contemporaries failed to find.   If this is the case, the same results could be derived only from structuralism.   I simply prefer the results only from structuralism to those from a combination of structuralism and post-structuralism.

Therefore, a specific cultural phenomenon is situated in four perspectives within the structuralism framework: 1) as a social norm in a synchronic perspective, 2) as an individual's act in a synchronic perspective, 3) as a social norm in a diachronic perspective and 4) as an individual's act in a diachronic perspective. In brief, according to structuralism, being governed by "langue," each individual's change in "parole" makes his or her "langue" in mind change. And, it is also true that the individual really feels his or her "langue" being stable.

Table 1

	Langue	Parole
Synchronic Perspective	1	2
Diachronic Perspective	3	4

Border-crossing and collateral-learning consider "culture" mainly from the point of the case 4) because they illuminate each pupil's change in science education: pupils' "parole" in the diachronic perspective. Since as-foreign-language focuses on the cultural difference in the synchronic perspective, this corresponds mainly to the case 1).

Although the case 2) appears to be irrelevant to border-crossing and collateral-learning or as-foreign-language, this is a pre-condition for both. Border-crossing and collateral-learning have to presume each pupil's identity because "diachronic identity depends on a series of synchronic identities." The case 2) also play a significant role in as-foreign-language because each pupil forms his or her identify with feeling social norms of the cultural unit to which he or she belongs. The perspective of the case 3) is far from science education research because social norms as "langue" hardly change from the viewpoint of science education. Actually, if "langue" alters rapidly, education must become impossible. However, the case 3) becomes significant when one intends to affirm the synchronic relativity of a culture by describing a history of social norms in the specific cultural unit. "Diachronic identity *also* depends on a series of synchronic identities" in this affirmation.

In border-crossing and collateral-learning, the "culture" is considered with an emphasis on each individual pupil's thought and behaviour in science classes. Whereas, in "as-foreign-language," it works as norms in which the institutionalized view of Western science is embodied. This is a social aspect of culture in science education. These two

types of "culture" are not expulsive but complementary as stated above. Thus, structuralism provides a new framework or science education research. Within the framework, science educators synthesize each individual pupil's behaviour and pupils' learning setting for science education.

In school science, Western science is basically a "langue" which pupils should learn irrespective of culture, but it is probable that Western science is already changed by another "langue" pupils experience in their daily lives. There, the "langue" varies from a family way of life to a canonized way of life by a religion embraced in a group of countries, depending on science educators' viewpoint. Perceiving strain between these two types of "langue," the world of school science and their everyday life-world, each individual pupil learns and becomes able to perform "parole." Owing to these two types of "langue," discussion on each pupil's "parole" may become a little more complicated than discussion in structuralism because a situation is usually presupposed that an individual is thought to experience a single language or culture as "langue." However, this rather complicated situation in science education research may be resolved by each science educator's clarifying his or her stance on cultural identity: which type of "langue" is or should be stressed on. Obviously, this is self-referential.

CONCLUDING REMARKS

As a rule, a culture directly connects with a way of life. People tend to make a stand against change in the way of life because the change sometimes demands to restructure their culture; anxiety must increases in their cultural identity. Since identifying Western science as the Western culture and refusing its universality, the present stance on science education has to explain why it is possible for non-Western people to accept and learn Western science.

The following idea may serve as a clue for science educators to explain this: Western science became a matter of "technology" since Scientific Revolution though it is believed to be a matter of "recognition." In this sense, "technology" means to be universal methods by which everyone can achieve the same aims in principle. Typically, Galileo bridged the intellectual transition from "recognition" to "technology" by combining scientific experiments with mathematical descriptions. After Scientific Revolution, to describe a natural phenomenon in a mathematic form is identical to understand it. Since one can learn

mathematics step by step regardless of learner's culture, Western science after Scientific Revolution can be learned in the same way. How to learn Western science is exactly similar to an acquisition of technology of mathematical description. Since mathematics appears to be universal, Western science seems to be learnable irrespective of culture. This is why many science educators believe in the universality of Western science.

Owing to their belief, science educators tend to lead themselves to blame pupils' cultural setting for science education. Therefore, the strain pupils perceive between the two types of "langue" becomes greater in non-Western countries. There, science educators must perceive the same strain that stems from the belief in the universality of Western science. If science educators liberate themselves from their confidence of it, they will be able to handle this strain of "langue." This can be done by means of the awareness that the universality of Western science is not reliable, as stated in Kawasaki (1996; 1999). I would like to emphasize that the combination between experiments and mathematic forms became possible only in the West. The legitimate acceptance of it is just particular to the Western culture, which is never universal by nature.

It is a nomenclature view of language that confirms this science educators' confidence. For instance, according to the nomenclature view, science educators regard the Japanese word "kansatsu" as precise equivalent of "to observe" in science education in Japan (Kawasaki, 1999). It is true that referents of "kansatsu" coincide with those of "to observe" to a certain extent admittedly, but the linguistic value of "kansatsu" differs absolutely from that of "to observe." For instance, as stated above, the Japanese word "kansatsu" can refer referents of "to contemplate" in an actual context. Therefore, even when a science teacher utter "kansatsu" in his or her science class lessons in Japan, the Japanese language or culture has already altered the idea "science education" to a certain extent. Moreover, Kawasaki (1996) reveals the same linguistic situation in science education regarding the Japanese term "shizen," which science educators regard as an equivalent of "nature" in Japan.

Therefore, the issue that needs to be discussed in the cross-cultural perspective is on pupils' linguistic or cultural setting for science education in addition to the issues with emphasis on each individual's change in "parole." The research on pupils' linguistic or cultural setting will assure pupils of their worldview fostered in their innate culture even when they cross borders and learn collaterally. In other words, science educators have to formulate rationale for science education where science educators assist pupils to preserve their cultural

or linguistic identity.   With the aid of structural linguistics, I have already proposed a strategy for the rationale: science education should be conducted as foreign language education (Kawasaki, 1996).   This focuses on social setting for science education.

In science education in non-Western countries, the culture by which pupils live is conceptualized mainly against the Western culture in science educators' mind.   For simplicity, I have presupposed in this paper that science educators share pupils' culture, for this is typical in Japan.   In this sense science educators have to assume the role as a comparatist who try to clarify the Japanese culture by comparing it with the Western culture.   In cultural comparative studies, a foreign culture works as a mirror that reflects the culture by which the comparatist actually lives.   On the contrary, it is by no means a comparative study where two foreign cultures are compared.

Thus, comparative studies might be based on some kind of ego-centrism or narcissism. Nevertheless, a genuine comparatist must conclude "the foreign culture is great because my culture is great."   He or she must be careful not to conclude "the foreign culture is minor because my culture is great."   A paraphrase of the desirable conclusion from the viewpoint of science education in Japan is: Western science is great because the Japanese culture is great. I would like to propose that this must be a philosophical essence of a programme for teacher training in Japan as well as non-Western countries.   By means of science education, i.e., learning the content of Western science and fulfilling expectations of their society, pupils will be led to find their own culture.   If proper interpretation is made, the present discussion is applicable to cases in the West where only subcultures relate to science education.   The degree of cultural difference is lower, but the same kind of attention must be made of course.

Note

Cited from Aikenhead & Jegede (1999).

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.... Maxwell'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....

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Appendix:

[But] none of this takes away from the fact that Foucault's corrosive intelligence has performed a work of inestimable value: that of demonstrating that there cannot be a coherent structuralism apart from constructivism (Piaget, 1973, p.135).