HOW TO COUNTERACT DISTORTING EFFECTS OF THE INSTRUCTIONAL LANGUAGE ON SCIENCE EDUCATION IN NON-WESTERN NATION-STATES

Addressing the problem

This paper proposes an application of metalanguage in order to counteract distorting effects on science education, especially the teaching of Western modern science; in the following, the term "Western modern science" is abbreviated to "W-science." The problem of distorting effects arises when science education is conducted by means of a non-SAE language[1)]. Having a responsibility to conduct science education regardless of their own cultural traditions, non-Western nation-states encounter the problem the present paper addresses. There, people cannot identify themselves with the legitimate successor to the Greco-Roman civilization, the cradle of W-science, which entails thinking about the world in the Greek way (Burnet, 1975, v).

As a rule, the formation of nation-states, into which nationalism "acts to organize all peoples" (Kohn, 1973), gave rise to science education as a social phenomenon. Each nation-state highly prizes its national language, and regards science education as vital at the same time.

> [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)

In the foregoing, "modern science" should be replaced by "W-science" according to the present context. As pointed out here, many non-Western nation-states deliver science education through the medium of their respective national languages. In doing so, these science educators implicitly accept the supposed universality of W-science, and also usually accept the following language setting for science education: W-science is taught by means of non-SAE languages. This leads these science educators to the supposition that science education is independent of the instructional language.

Language and worldview

However, science education depends primarily on the instructional language, because a language inevitably entails a worldview innate in the language (Whorf, 1959; Suzuki, 1993). In other words, using a specific language is accepting the worldview entailed by the language. Taking this into consideration, Kawasaki (1996; 2002) has revealed that science education in Japan is under the influence of the Japanese worldview entailed by the Japanese language as the instructional language. For example, the Japanese term "shizen" is supposed to be the Japanese counterpart of "nature" in science education in Japan; however, this Japanese term usually refers to the supernatural in the Japanese language. Therefore, whenever science teachers utter "shizen," pupils recollect the supernatural even in the science classroom. Such conceptual confusions cause distorting effects owing to linguistic incommensurability. To put it strongly, in the Japanese science classroom the Japanese worldview is described in terms of W-science.

Thus, the linguistic incommensurability between W-science as an SAE language and the Japanese language introduces confusion about W-scientific concepts in pupils' minds: the distorting effects caused by the instructional language. In order to draw science educators' attention to the distorting effects, Kawasaki (2002) proposed the notion "linguistic mode of

science education," for example, the Japanese language mode of science education. This notion illuminates differences between an SAE language mode of science education and a non-SAE language mode. Drawing a distinction between these modes of science education is based on differences between the worldviews concerned.

The axiomatics model of science education

A paradigm, which shows how linguistic modes of science education can be produced, is definitely necessary for comparative studies of language modes of science education. The paradigm and linguistic modes form a genus-species relationship, which makes it possible for science educators to carry out comparative studies. The axiomatics model of science education (Kawasaki, 2006) works as the paradigm, and distinguishes among the axiom, the postulate and the theorem stages of cognition in the same way as in geometry.

At the axiom stage, a system of axioms is established. Each axiom has indefinable terms and logical terms that form a relationship between the indefinable terms. Every indefinable term has nil intension and unlimited extension. A possible axiomatics model of science education is:

[SCIENCE] is a system of [KNOWLEDGE] about [NATURE]	(A1)
[SCIENCE EDUCATION] is a system of teaching [SCIENCE].	(A2)

In the foregoing, indefinable terms are expressed in capital letters and put into square brackets. Sharing the indefinable term [SCIENCE], the axioms (A1) and (A2) form an axiom system. The extension of [SCIENCE], for example, encompasses not only W-science but all indigenous knowledge systems about [NATURE]; the indefinable term [NATURE] expresses the world as such, the world that is not yet interpreted by any language. The other indefinable terms should be understood similarly (see Kawasaki, 2006 for details).

At the postulate stage, an innate worldview is unwittingly chosen according to the instructional language. In accordance with the worldview, the language mode of science education is born at the theorem stage. For instance, the Japanese mode of science education is a result of the combination of the axioms and the traditional worldview inherent in the Japanese language. If the W-scientific worldview inherent in SAE-languages is combined with the axioms, such language modes of science education are free from distorting effects. The W-scientific worldview is commensurate with the worldviews pupils are expected to acquire in their communities.

Metalanguage in science education

An issue that needs to be discussed in non-SAE language modes of science education is how to counteract the distorting effects. The necessary condition is that science educators become aware of the distorting effects. By using the axiomatics model, science educators will draw their attention to the differences between the W-scientific worldview and the worldview pupils are expected to acquire in their non-SAE communities. In science educators' explanation of the differences, the language they use can be properly called metalanguage.

Usually, metalanguage is defined as: the expressions used for describing or referring to language. This definition needs revising according to the present context in which a language entails a worldview innate in the language. The revised definition is: metalanguage is an explanation of

worldview. The present definition assures science educators that the instructional language as metalanguage can go beyond the worldview entailed by the instructional language as such.

Imagine a non-SAE language-culture community, where people share a non-SAE language entailing a worldview different from the W-scientific worldview. There, the non-SAE language is the instructional language, as in Japan. In this non-SAE language mode of science education, pupils are confronted with two worldviews different from each other: the W-scientific and the non-SAE worldviews. From science educators' viewpoint, they have to deal with these two worldviews by using the single instructional language, the non-SAE language. Consequently, science educators explain the W-scientific worldview by using the non-SAE language as a metalanguage. Thus, worldview education is non-SAE language modes of science education where science educators are always conscious of the differences in worldview (Kawasaki, 2006).

Science education as foreign language education

In worldview education, science educators have to understand the differences between these two worldviews in concrete ways, as Kawasaki (2002) showed in the Japanese language mode of science education. Worldview education is entirely based on metalanguage expressed by the non-SAE language. This linguistic situation science educators encounter is essentially similar to what happens to foreign language educators, because both types of educators have to cope with two worldviews (or value systems) contradictory to each other. Clearly, foreign language educators use metalanguage when they explain the foreign language grammar in pupils' first language.

However, there is a dissimilarity between the two types of education. In foreign language education, pupils are always conscious that they are confronted with the two languages, worldviews or value systems. They do not lose consciousness of their dealing with the two languages. Their consciousness prevents them from conceptual confusion. Furthermore, only those pupils who learn a foreign language can realize their first language: *Those who know nothing of foreign languages know nothing of their own*. This maxim is attributed to Goethe as is well-known.

By contrast, as a result of the supposed universality of W-science, science educators do not realize that they have to deal with two worldviews. This is an essential reason why science educators encourage pupils to replace their worldview by the W-scientific worldview. It should be emphasized that these science educators undermine non-Western nation-states by means of science education. However, worldview education will make it possible for pupils to develop correct understandings of W-science and to foster their sound national identity at the same time, because of their willing to pay attention to worldview differences. This must be supported by a paraphrase of the maxim above: *Those who know nothing of the W-scientific worldview know nothing of their own*. Thus, science education should be associated with foreign language education. Such science education is worldview education, where metalanguage plays a critical role. This is the way to counteract the distorting effects of the non-SAE instructional language.

The Malaysia challenge

In addition, it should be noticed that metalanguage conveys the same meanings whatever language is used for expressing the metalanguage. As a result, the issue concerning the instructional language becomes less significant in worldview education. This perspective can justify science education being delivered by means of an SAE language (e.g., the English

language), even in a non-Western nation-sate. If the non-Western nation-state consists of plural language-culture communities, the merits of linguistic equity may lie in a science education delivered by means of the SAE language. In this sense, the Malaysia challenge to conduct science and mathematics education in the English language is justified if educators and their pupils have enough ability to handle the English language.

This linguistically challenging science education has the following two advantages, but only on condition that science educators always draw pupils' attention to the differences between the worldviews concerned. First, with the aid of the metalanguage given in the science classroom, pupils will be able to readily distinguish the W-scientific worldview from the worldviews inherent in their respective communities. Then, being able to make this distinction between worldviews will protect pupils from conceptual confusion about W-scientific concepts, and will make it possible for them to foster the sound national identity they are expected to establish.

Second, using the English language liberates pupils from conceptual confusion about W-scientific concepts because the English language entails a worldview commensurate with the W-scientific worldview. In successful worldview education, science educators will never encourage pupils to replace their inherent worldviews by the W-scientific one, because science educators naturally have a relativistic view of W-science. Hence, the Malaysia challenge in science education provides a constructive perspective in the field of science education research in a non-Western nation-state consisting of multi-cultural communities.

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Notes
1) "SAE" is an abbreviation for "Standard Average European" coined by Whorf (1959), a US linguist. English, German, French are examples of "SAE." The notion "SAE" divides the world into two: Western and non-Western nation states.

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