HOW TO COUNTERACT DISTORTING EFFECTS OF INSTRUCTION LANGUAGE ON SCIENCE EDUCATION IN NON-WESTERN NATION-SATES

Addressing Problem
This paper proposes an application of metalanguage in order to counteract distorting effects on science education, the teaching of Western modern science; in the following, the term “Western modern science” is abbreviated to “W-science.” The problem of the 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 legitimate successor to the Greco-Roman civilization, the cradle of W-science. It is 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 praises 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, non-Western nation-states naturally arrange science education by using their national languages respectively. There, science educators accept the supposed universality of W-science, and usually accept the following language setting for science education: W-science is taught by means of non-SAE languages. This leads science educators to the supposition that science education is independent of instruction language.

Language and Worldview
However, science education depends primarily on the instruction 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 instruction 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 the distorting effects owing to the linguistic incommensurability. To put it strongly, the Japanese worldview is described in terms of W-science in the Japanese science classroom.

Thus, the linguistic incommensurability between W-science as an SAE language and the Japanese language introduces confusion on W-scientific concepts to pupils’ mind: the distorting
effects caused by the instruction 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 of it. Drawing a distinction between these modes of science education is based on the 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 on language modes of science education. The paradigm and linguistic modes of it form a genus-species relationship, which makes it possible for science educators to carry out the 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:

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\begin{align*}
[SCIENCE] & \text{ is a system of [KNOWLEDGE] about [NATURE],} \\
[SCIENCE EDUCATION] & \text{ is a system of teaching [SCIENCE].}
\end{align*}
\]

(A1) (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 instruction 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 axiomatics model, such language modes of science education are free from the 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 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: the expressions used for describing or referring to language. This definition needs revising according to the present context that a language entails a worldview innate in the language. The revised one is: metalanguage is an explanation of worldview. The present definition assures science educators that the instruction language as metalanguage can go beyond the worldview entailed by the instruction 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 instruction language like 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 instruction language, the non-SAE language. Consequently, science educators explain the W-scientific worldview by using the non-SAE language as metalanguage. 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 the concrete 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 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 themselves from conceptual confusion. Furthermore, only those pupils who learn a foreign language can realize their first language. This is supported by the maxim attributed to Goethe: Those who know nothing of foreign languages know nothing of their own.

By contrast, because of the supposed universality of W-science, science educators are inclined to overlook the point that they have to deal with the 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 science educators undermine non-Western nation-states by means of science education. However, worldview education will make it possible for pupils to make correct understandings of W-science and to foster their sound national identity at the same time, because they always pay their 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 instruction language of non-SAE.

Malay Challenge
In addition, it should be noticed that metalanguage conveys the same meanings whatever language is used for expressing the metalanguage. As a result, only if science educators consider
science education to be worldview education, the issue concerning the instruction language becomes less significant. This can explain science education by means of an SAE language, e.g., the English language, even in a non-Western nation-sate. If the non-Western nation-sate consists of plural language-culture communities, merits of linguistic equity lie in science education by means of the SAE language. In this sense, Malay 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.

The challenging science education has the following advantages on the condition that science educators always draw pupils’ attention to the differences between the worldviews concerned. Then, pupils are ready to distinguish the W-scientific worldview from the worldviews inherent in pupils’ respective communities with the aid of the metalanguage given in the science classroom. Pupils’ distinction will protect themselves from conceptual confusion on W-scientific concepts, and will make it possible for pupils to foster their sound national identity they are expected to establish.

Furthermore, using the English language liberates pupils from conceptual confusion on W-scientific concepts, because the English language entails the worldview commensurate with the W-scientific worldview. If worldview education is successfully conducted, science educators will never encourage pupils to replace their inherent worldview by the W-scientific one on the basis of science educators’ relativistic perspective to W-science. Hence, Malay challenge in science education provides a constructive perspective in the field of science education research, especially in science education research in multi-cultural societies.

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

References
