3. Multi-science Perspectives and Implications for Science Education: Reflections from Japan's Experiences

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Introduction

Since early 1980s, I have been consistently struggling with the question, '*What is an ideal science education enterprise for non-western learners living in our contemporary societies*?' by deciphering the very nature and unique characteristics of Japanese elementary science program (called *Rika*), where two mutually different cultural/epistemological ways of knowing natural world around us ('Western Modern Science' and 'Japanese indigenous ways of knowing nature') have been 'unconsciously' tried to be amalgamated (Ogawa, 2002) and harmonized (Ogawa, 1986). Despite this rather curious nature of elementary Rika, Japanese science education has celebrated a great success for these several decades in terms of R and D arenas as well as students' higher performance in international surveys on science achievements.

In this sense, I have had confidence that Japanese Rika can serve as one of the interesting and successful models of science education programs for learners (despite their age) who are in their very initial phases of encountering western science, at least, in non-western society. Ideas like 'science as a foreign culture' (Ogawa, 1986, 1989), 'science education in a multiscience perspective' (Ogawa, 1995), 'four-eyed fish' (Ogawa, 1996) and 'a stratified and amalgamated model of knowledge and cosmology' (Ogawa, 2002) are derived from such deliberation.

The present review talk, after a very brief overview of research trends in cultural studies in science education, will focus on my personal reflection on the ideas mentioned above, and explain their essential features in detail, especially, how they were deeply affected by the decipherment of the nature of elementary Rika, which has been an amalgam of western science and 'Loving Shizen' as one aspect of Japanese ways of perceiving Shizen (Nature). Then, it proceeds to an extensive description of several aspects of elementary Rika: (1) amalgamated nature of Rika objectives (Ogawa, 1986); (2) origin of the idea, Rika (Ogawa, 1998a); (3) episodes from Rika classes (Ogawa, 1998a, 2011). The talk will end up with consideration of 'education of indigenous science' through a model for decipherment of nature of contemporary societies and its implications to contemporary science education (Ogawa, 2008a, 2008b).

Cultural Studies in Science Education (CSSE)

Cultural (or culture) studies have been visible as one of the research areas within science education from around 1990s. A specific strand for cultural issues has been developed at international conferences on science education and even international conferences for cultural studies of science education are not rare. Number of PhDs as well as Masters' studies focusing on cultural issues have been increasing all over the world. Major science education research journals (*Science Education*, *Journal of Research in Science Teaching*, and *International Journal of Science Education*) have occasionally published special issues on cultural studies. Also, monographs and edited books directly relevant to cultural studies of science education have been published (Aikenhead, 2006; Cajete, 1999; Cobern, 1998; Hines, 2003) and even a unique academic journal, *Cultural Studies of Science Education* established in 2006 continues publishing papers. These are good evidences that the cultural studies in science education are now regarded as an established research area in science education.

This 'culture sensitiveness' within science education, where the idea, 'western science as one of sub-cultures in western tradition' is shared, can be traced back to Maddock's (1981) memorable review article, '*Science education: An anthropological viewpoint.'* Before that, most science educators had identified cultural and linguistic 'hazards' and 'problems' prohibiting 'effective science teaching' in non-western societies (see Wilson, 1981a, 1981b) but were unaware of *culturality* or *value-laden-ness* of 'science' and/or 'education.' Few had tackled the issues from the very viewpoint of learners who are vividly living in such non-western cultural and linguistic environments.

But from around early 1990s, learners' culture-sensitive voices had been expressed even in several major academic journals, where several relevant ideas were presented. Among them are 'world-view theory' (Cobern, 1991), 'collateral learning' (Jegede, 1995), 'science education in a multi-science perspective' (Ogawa, 1995), 'cultural border-crossing' (Aikenhead, 1996), 'science education as foreign language education' (Kawasaki, 1996) etc.

Then, what are common features among research agendas of cultural studies in science education? Pomeroy (1994) tried to categorize research on cultural contexts in science education and identified nine research agendas as follows:

1. Support systems for under-represented groups;
2. Localized context of the science curriculum;
3. Appropriate teaching strategies for diverse learners;
4. Inclusion of the contributions of those generally omitted;
5. Study of the real stories of Western scientific discovery;
6. Science for language minority students;
7. Study of the science in 'folk knowledge' or 'native technologies';
8. Bridge the world view of students and that of Western science; and
9. Explore the beliefs, methods, criteria for validity, and systems of rationality upon which other cultures' knowledge of the natural world is built.

But Jegede and Aikenhead (1999) argued that only the agendas 7 to 9 can be regarded as cultural studies, because while the agendas 1 to 6 tended to assimilate pupils into western science, they challenge us to conceive alternatives to assimilation. Thus, cultural studies in its narrowest sense shares a stance that researchers should stand by the learners' side, not by the western science side, at least at the very start of their respective research programs. A variety of research orientations among the studies in *Cultural Studies in Science Education* is summarized in Table 1.

Table 1: **Varieties of research orientations among the cultural studies in science education.**

Domain	Items
Target Learners	Non-western people living in developing countries, Non-western people living in developed countries, Aboriginal (or First Nation's) people living in western or non-western countries, Under- represented minority and/or immigrant groups living mainly in metropolitan urban areas
Contents	Western modern science, Western modern ways of knowing nature, Traditional knowledge, Indigenous knowledge, Traditional ways of knowing, Indigenous science, Learners' empirically based ways of knowing nature
Contexts	Daily life world, Place-based, Languages, Sustainability, Globalization, Diversity, Equity, Gender, Transformation, Identity, Values
Teaching/Learning	Border-crossing, Multi-science perspective, Collateral learning, Worldview education, Science learning as foreign language learning

My Fundamental Stances and Concern about Science Teaching

About 30 years ago, I had an opportunity to teach science (biology, chemistry, and sometimes even an introductory physics) at one of the bottom-ranking high schools, whose students showed little interest in any classes (including science classes). For a novice science teacher, who had just graduated from an undergraduate program from one of the prestigious Universities (majoring in plant physiology with science education minor) with a high school science teacher certificate, the students of the school were 'aliens.' Senior teachers advised me that the class was successful if all the students stayed in the classroom whether I could teach science or not. Indeed, some students kept chatting with one another, and others kept sleeping. Few were involved in learning science. Some could not calculate even fractions, ratios or proportions. Thus, I began to think why should I teach science to them, or what should I teach them in science class?

This was my first encounter with science education issues and these questions have guided my stances and concern towards science education: I should serve as an educator, not as a scientist. I wanted to see school science by positioning myself on the side of education, not science. I wanted to stand at the learners' side, not at the side of science. I wished to see subject matter science, as a sub-culture of the western modern, and thus, as a foreign culture for the students learning science. Once 'science' is regarded as a foreign culture for the students, why should we teach it to the students? If we need to teach it, how should we teach/learn school science without injuring or denying, but by respecting and sharing learner's own non-western worldview and identity? Or how should we teach/learn school science without our committing to Scientism? (Ogawa, 1998b). These fundamental stances and concern to science teaching are still serving as strong inner motives toward my science education research.

Personal Commitment to the Idea, 'Multi-Science Perspective'

In my paper (Ogawa, 1995), I argued first an idea, 'multi-science perspective.' At that time, my central question on the trend of multicultural science education was why 'multicultural,' and why not 'multi-science'? Here, in my mind, the term, [science][1], appeared not as the meaning of Western Modern Science, but as a new superordinate concept. Thus, I simply defined [science] as 'a rational perceiving of reality.' In this definition, 'rationality' is not necessarily a 'universalist rationality,' but rationality found within each cultural context, and 'perceiving' means both 'the action constructing reality and the resultant construct of reality.' Answering the question, how [science] we could identify or distinguish different types of [science], the first one is scientists' [science], that is Western Modern Science. It could be defined as *'a collective rational perceiving of reality, shared and authorized by the community of scientists.'* The second one is a community's [science] that is, Indigenous Science, defined as *'a culture-dependent collective rational perceiving of reality, shared with the community people.'* The last one is individual's [science], named Personal Science, defined as *'a rational perceiving of reality, which is unique to each individual.'* Caution must be taken that intention of the idea is not to relativize Western Modern Science itself, but to develop a new type of superordinate concept, [science], and deliberate another type of 'pluralistic' (Aikenhead, 2000) education on [science] within multi-[science] perspective.

In this idea, Indigenous Science (a community's [science]) should not be regarded as a collection of indigenous knowledge. The term 'knowledge' readily presupposes its comparability with knowledge in Western Modern Science and tends to be evaluated and valued within the validity of Western Modern Science. Indigenous Science is a perfectly different enterprise from Western Modern Science, and covers a much broader arena than what is named as 'indigenous knowledge.'

Thus, the idea, '[science] education in a multi-[science] perspective, suggests a possibility of totally different kind of [science] classes from our ordinary Western Modern Science classes. In such [science] classes, not only scientists' [science], but also community's [science] as well as individuals' [science] are actively at work and the learners can have chance to know (or share) all of the [sciences] at work simultaneously through the unintentional as well as intentional comparisons among them. Science teacher brings the scientists' [science] that is, Western Modern Science in the class. Also, she/he brings her/his own community's [science] as well as her/his individual's [science] as well. Students, if they come from various cultural backgrounds, bring various kinds of community's [sciences] as well as individual's [sciences]. In principle, every kind of [science] can be appreciated and respected in [science] classes. But this does not necessarily mean each of them should be valued equally. Differential valuing and weighing should be possible. Decisions should be left to respective teachers or may be to respective students as well.

Are there any examples showing this type of multi-[science] perspective at work? My answer is 'yes.' It is found in Japanese Rika (school science) classes. How are the other types of [science] than Western Modern Science (scientists' [science]) at work in Japanese Rika classes, especially in elementary school level? It will be explained in the next section, but attention should be paid to the fact that there are only few foreigners in Japan (only 1.5%) and almost all of the people living in Japan are Japanese with quite similar fundamental cultural backgrounds. In this sense, teachers as well as students can bring only one community's [science] even if their individual's [science] might be different from one another.

Elementary Rika Classes: Science Classes Japanized

Rika is a Japanese school subject corresponding to school science in western countries, but Ogawa (1998c) argues that Rika is not western type of school science, but a 'Japanized' school science. Overall objectives of elementary Rika are identified in the course of study of elementary school (MEXT, 2008) as follows:

Rika encourages pupils to: (1) commune with Shizen (nature), (2) perform observations and experiments with insight, (3) acquire the ability of problem-solving, (4) acquire the feeling of loving Shizen (nature), (5) understand natural things and phenomena with reality, and (6) acquire the scientific view and way of thinking (Tr. by author).

These six objectives can be categorized into two groups. The first group consists of (2), (3), (5), and (6), and the second group includes the remaining (1) and (4). The objectives of the first group are very similar to any objectives relating to education of Western Modern Science. On the other hand, the objectives of the second group are not directly relevant to Western Modern Science itself. Here, I call it 'Education of Loving Shizen'[2] which means that pupils are to learn by direct interaction with Shizen, feel Shizen, feel empathy with Shizen, and love Shizen. The idea, Shizen (nature) for Japanese, is so complicated that it is not easy to explain or understand it even for Japanese. Full discussion on the idea, Shizen including its historical development is found in Ogawa (1998a, 2002) and Aikenhead and Ogawa (2007), but brief description of Shizen will help the audience.

Shizen does not mean what nature means (i.e., the whole system of the existence and arrangement of forces and events of all physical life that are not controlled by humans; Collins English Dictionary, 1994). Instead, Shizen represents a metaphysics constructed by each Japanese person in accordance with a common feature among Japanese people, nurtured by their historical ways of knowing nature (Minamoto, 1985). Using Ogawa's (1995) expression, Shizen can be regarded as 'Japanese people's collective rational perceiving natural world surrounding them', where 'perceiving' includes not only a thing perceived but also a perceiving agent.

Ogawa (2002) claimed that Education of Shizen ('Loving Shizen' is one of its components) serves as a type of cosmology education for Japanese people. This does not necessarily mean that cosmology education should appear in Rika classes exclusively and explicitly. It can also be serving as a component of other educational settings than Rika. But, cosmology education sometimes co-exists unconsciously in school science, Rika. Furthermore, it may be said that it serves as a kind of identity education as well. Japanese science teachers as well as general public are usually not aware of this duality of Rika. Rika is Japanese education that helps to transmit the historical Japanese sense of Shizen and Japanese sense of what the West calls nature simultaneously, and lays the foundation for a distinctively Japanese view of science. The rationale for Rika and education of Shizen lies deep within Japanese history and culture (see Aikenhead and Ogawa, 2007; Ogawa, 1998a).

Examples of 'Loving Shizen' in the Rika Classes

'Education of Loving Shizen' (as cosmology education) in the context of Rika classes is usually not explicitly visible compared to education of Western Modern Science. Subject matters, major contents and major lab activities in Rika are quite similar to those in elementary science in western world. No subject matters or contents specific to 'Loving Shizen' is dealt with in Rika classes.

It is in the study of living organisms that 'Loving Shizen' in Rika is most visible. There are many examples (Ogawa, 1998a, 2011). Pupils cultivate plants such as sunflower, loofah, and Japanese morning glory. They plant seeds and water them. They keep watch and take notes on how the seedlings are growing. They draw pictures of their plants. They even talk to the plants. They think of plants like their family members. They are encouraged to show love for their plants through the care they give to the plants. That is what is expected. When asked why do plants grow better in sunny weather than in cloudy or rainy weather? Pupils frequently answer: 'Because they love sunny days just as we do' or 'Because they need warmth to become vital'. Teachers respect such answers. Third graders keep and care for butterflies in the classroom. They take cabbage leaves with butterfly eggs and watch them hatch. They take care of larva by giving fresh cabbage leaves. They watch the process of pupating, emergence and at last, they allow the butterfly to fly back into the free sky. They watch the whole life process of the butterfly. They report the color, size and form of the larva.

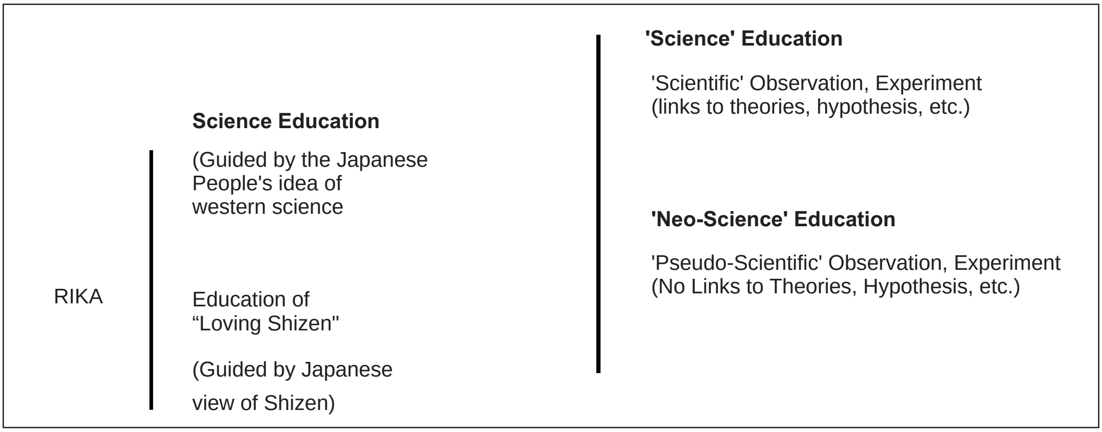
However, what they act out is not 'scientific observation' in the Western sense but their love for the butterfly. In some cases children even name the butterflies. Teachers promote such attitudes and activities among the pupils.

Fifth graders try to 'observe' flowers of certain plants. Scientifically, the observation should be performed with a sort of flower structure (pistil, stamen, petal and sepal) in mind. For that purpose, they need to separate the object (flowers) from the observer (the students themselves), but sometimes, scientific observation turns to *Kansatsu*. Observation in scientific term is translated into a Japanese term, Kansatsu. But, as Kawasaki (1992) argued, Kansatsu is readily understood as 'gaze' or 'contemplate' because of a strong influence of original meaning of Japanese term Kansatsu, where psychological distance between the object and the observer gets closer and closer and ultimately the object and the observer psychologically become one and inseparable. Thus, some of the students are trying to Kansatsu (not observe) the target flower without picking it up from the living plant, because they have unpleasant feeling on picking the target flower up from the plant. This mentality comes from 'Loving Shizen.' In the lower-secondary Rika classes, another example is dissection (*Kaibou*). After the Rika class of dissecting fish or frogs, students do not throw them away into the garbage can, but bury them into the ground and even pray for them. Even the science teacher of the class encourages and promotes such activities.

Three Components of Actual Rika Classes

As explained above, Japanese elementary Rika classes consists of two major and differently oriented components, 'Education of Western Modern Science' and 'Education of Loving Shizen.' However, much more careful insight into actual elementary Rika classes uncovers another 'hidden' component within 'Education of Western Modern Science,' which I called education of 'neo-science' (Ogawa, 1998a). Neo-science has activities that model real 'science' but are not real 'science.' For example, observation and/or experiment can be called 'scientific' when they are guided or accompanied by certain kinds of mental processes (like theory-building, hypothesis-proving) of the observer and/or experimenter. But, sometimes in elementary Rika classes, students are performing the activities (observation and/or experiment) with nothing working in their minds. For them, performance (doing observation and/or experiment) in itself is the main aim. They simply enjoy activities without any spirit of Western Modern Science, though they believe they are mimicking the spirit. The more the students get chance to do practical work, the more is 'neo-science' possible to appear among them in Japanese elementary Rika classes. Also, here again, few elementary teachers are aware of this 'pseudo-scientificity' because superficially they seem to be deeply involved in the activities (observation and/or experiment).

Thus, in total, we say that three different types of components are working in elementary Rika classes (Figure. 1). Important point is that usually elementary teachers (even elementary teachers with science major) are unaware of the heterogeneity and worse is that they believe what is treated in Rika classes is 'real' Western Modern Science.



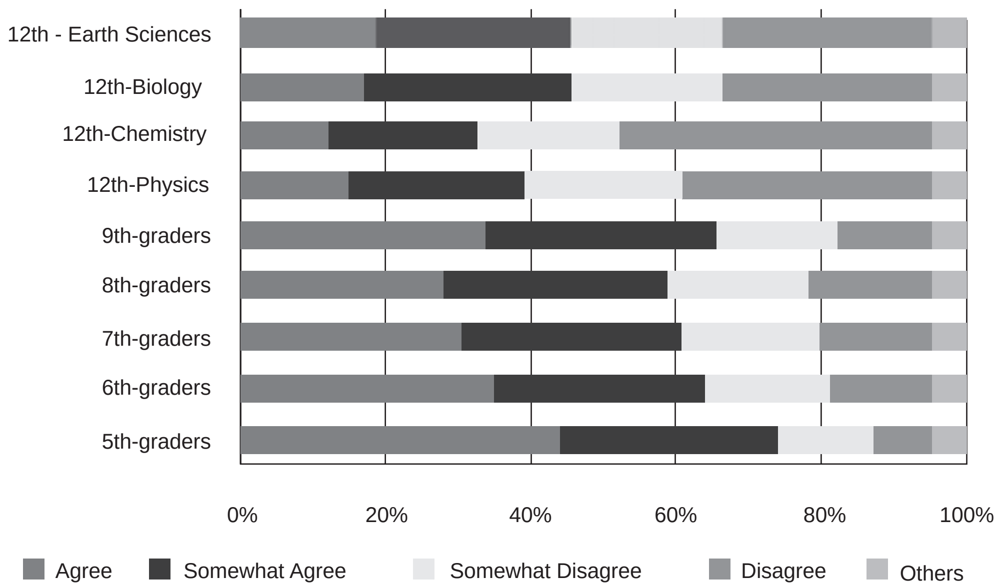


Figure 2: Japanese students' responses to a question, I like learning Rika. Data of 5th to 9th graders are from **NIER (2005) and those of 12th graders experienced Physics, Chemistry, Biology and Earth Sciences classes respectively are from NIER (2007). For upper-secondary students, the question was modified as 'I like learning physics' etc.**

What are Japanese students' responses to these three components? National survey results (NIER, 2005, 2007) shown in Figure 2 indicated that elementary students liked learning in Rika classes, but as they got older and were in lower-secondary (7th to 9th) level and in upper-secondary level (12th), they disliked learning in Rika or science subjects. Why does this happen?

In Japanese Rika classes, 'Loving Shizen' components are much more emphasized at elementary level, but in lower and upper secondary level there is not much emphasis laid upon it. 'Neo-science' requires students to have opportunities to be involved in practical work settings. In Japan, Rika classes in elementary and lower-secondary levels contain a lot of practical activities, which are found even in the textbooks. On the other hand, while in upper-secondary level the course of study strongly suggests the need of practical work, in Rika classes (physics, chemistry, biology, and earth sciences), students can experience only a limited amount of practical activities mainly because of (1) pressure of entrance exams and (2) too much content matter to learn and no time to do practical work. Therefore, in elementary Rika classes with rich experiences in 'Loving Shizen' and practical activities in science (which sometimes turn out to be 'Neo-science') and in the lower-secondary Rika classes, activities relevant to 'Loving Shizen' are reduced, but practical activities (easily turning out to be 'Neo-science') are still rich. At the upper-secondary level Rika classes concentrate on 'Western Modern Science' components alone. The relative ratios of the three components at elementary, lower-secondary and upper- secondary level can explain the fact that Japanese kids like Rika classes very much in elementary level, but as they get older they lose their liking for Rika classes. The decrease of relative ratios of the components, 'Loving Shizen' and 'Neo-science' is the main reason why students lose their liking for Rika classes. Thus, it seems that in Rika classes they may not like to learn 'Western Modern Science', which is a foreign culture for them, from the very beginning, but they do like to learn 'Neo-science' (just like a magic or toy) and 'Loving Shizen' (as a kind of Indigenous Science, community's [science]).

Origin of 'Loving Shizen' Component in Elementary Rika Objectives

The unique component, 'Loving Shizen' in Rika Objectives has a long history. As is shown in Table 2, the relevant elements (the lower columns) were involved in the Rika objectives when Rika was first introduced in Japanese elementary school in 1891. Since then, these have survived almost all of the revision processes of the Course of Study. This means that for the Japanese people, elementary school subject dealing with natural world needed to include such elements in overall objectives of the subject. Of course, such elements had no link with Western Modern Science.

In Japan, thus, for about 120 years, Japanese people have learned Western Modern Science (scientists' [science]) and 'Loving Shizen' (Indigenous Science (community's [science])) simultaneously in elementary Rika classes. An important point here again, is that most of the Japanese, including elementary teachers and science teachers did not realize that Rika was in this kind of amalgamated nature in its objectives. This lack of awareness among Japanese people is one of the major reasons why this unique school subject could survive in this unchanged form.

***Table 2:* Historical changes in elementary Rika objectives in Japan.**

Elements \ Year of Promulgation	1891	1900	1941	1947	1958	1968	1977	1989	1998	2008
Kansatsu (Observation) and Jikken (Experimentation)	X	X	X	X		X	X	X	X	X
Knowledge of natural things & phenomena	X	X	X	X	X	X	X	X	X	X
Scientific views & ways of thinking			X	X		X		X	X	X
Problem-solving abilities								X	X	X
Scientific attitudes (Shizen Ninshiki)			X	X		X				
Relationship between science and daily life	X	X			X					
Abilities of & attitudes toward exploring Shizen				X			X			
Attitudes toward learning directly from Shizen			X		X					
Feelings of communing with Shizen			X	X	X	X	X	X	X	X
Feelings of loving Shizen	X	X	X	X	X		X	X	X	X

How Did Japanized School Science Rika Develop?

In order to answer the question, we must return back to a point that school subjects including Japanese school science, Rika, are fundamentally one of the means for achieving more general goals and aims of school education. In general, discussion among science educators on goals and aims of science education (DeBoer, 2000; Reiss, 2007; Roberts, 1982; Wellington, 2001) has been concentrated on educational values of science alone.

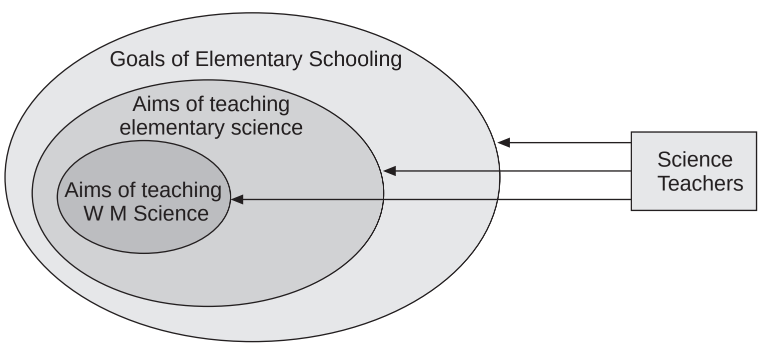


***Figure 3:* Teaching Rika in elementary schools.**

However, an important point to be discussed in advance is the educational roles of teaching science to achieve the goals and aims of schooling (or school education) itself. Figure 3 shows such relationship among various level of goals around 'teaching school science in elementary school in Japan.'

Elementary schooling in Japan, as a whole, is expected to contribute to child's development as a complete human being. From this point of view, to become a person of knowledge is not necessarily the top priority. Rather, the top priority is laid on becoming a person with moral and ethical norms and/or having wisdom as a human being. The origin of this priority may date back to the very beginning days of elementary schooling in Japan, because Japanese school education system at that time was under the strong influence of Prussian education system (Ogawa, 1998c, 2011). Although space does not allow more discussion of this historical perspective, contemporary Japanese teacher educators as well as teachers themselves, tend to be more sympathetic to the notion of *'Bildung'* ('cultivation/edification' (Masschelein and Ricken 2003)) in German tradition (Westbury, Hopmann, and Riquarts, 2000) than that of 'teaching' or 'education' in English tradition. For example, Wimmer (2003) explained Bildung as follows:

> *The German concept of Bildung encompasses a highly complex web of meanings and usages which render it particularly untranslatable. Bildung denotes both the processes of learning – the development of the personality or identity – and the results of those processes. In contrast to the concept of learning or development, the concept of the process of Bildung implies that the individual goes beyond himself (sic) in a way that is neither teleological nor goalless in the course of his (sic) individual self-realisation and the concomitant advancement of the species. This process is considered to have no goal (freedom) and to have a goal (fulfilment or perfection), to be determinate (inner nature) and indeterminate (self-creation). (p. 185)*

The spirit of Bildung has been acceptable because certain aspects are regarded to fit or harmonize with the notion of how Japanese children should be trained in elementary schooling among contemporary Japanese elementary science teachers as well as elementary teachers in general. For example, two leading elementary science teachers express such sympathy in their writings:

> *What I have been keeping in my mind is 'educating humans' or 'formation of healthy individuals' through teaching the subject Rika. (Ueno, 2006, p. 19)*

> *Rika is one of the school subjects that serves as 'educating humans' based upon Japanese original views of Shizen, views of culture, and views of humans. (Ishii, 2006, p. 17)*

Thus, Japanese elementary teachers when teaching Rika classes take care of, not only the 'aims of teaching Western Modern Science' and 'aims of teaching elementary science (including Loving Shizen), but also 'the general goals of elementary schooling.' Teaching of 'Western Modern Science,' teaching of 'Cosmology and Identity (Loving Shizen),' and teaching of 'Moral as a Japanese' are simultaneously treated in the same Rika class. In this sense, elementary school science in Japan (Rika) can be said to be a school subject, 'Japanized elementary science.'

As explained above, Japanese elementary Rika classes consist of quite unique characteristics in terms of its components. However, curiously enough, results of PISA and TIMSS for several years have shown Japanese students' higher performance in science or scientific literacy, despite the heterogeneity in the elementary Rika classes. Is it a miracle, magic, or mystery? It is an issue which is not yet resolved. But at least, the component, 'Loving Shizen' does not seem to inhibit students' performance in learning Western Modern Science. This implies that in 'school science', it is possible to include something beyond 'teaching/learning Western Modern Science.' Also, it is important that the aims of 'school science' should be set under the general goals of schooling and teachers should take note of this seriously. From this point of view, quality elementary science teachers are needed to cope with factors other than just 'teaching components from Western Modern Science.' In this Japanese specific case, they should prepare for supporting students' self-development as a human being, and teaching 'Loving Shizen' (a component of Japanese Indigenous Science), as well.

Education of Indigenous Science

Let me go back to the issue of community's [science] or Indigenous Science. Sometimes questions are asked: Why should it be taught? Is it a past knowledge set? And how and where should it be taught? I would like to answer these questions.

The question on the educational value of Indigenous Science is sometimes closely linked with another question, whether Indigenous Science is a past knowledge set or past ways of knowing in a certain community. However, I must say that Indigenous Science is not the past, but the present. In order to respond to the question, I need to explain how I perceive the reality of our contemporary society. Figure 4 indicates a typical model of civilization development, which is widely held by western people. However, I prefer the model which may be called 'Stratified Amalgamated model of civilization development' (Figure 5). In this model, past civilizations never disappear and new ones are accumulated on the older ones. Also, an important point here is that each civilization stage holds, respectively, a distinctive set of values, worldviews, activities, praxis, knowing, skills and education institutions (Figure 6), which sometimes happen to merge rather mildly with one another in the civilization borders, and we are living in the resultant amalgamated reality (Figure 7). In this sense, we can say our indigenous (fundamental) values, cosmology and identity are still vividly alive in our community's perception of reality, that is, Indigenous Science (community's [science]).

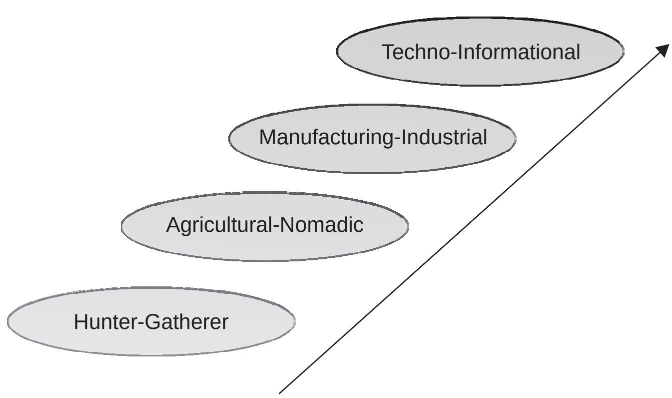


Figure 4: **Typical linear model of civilization development.**

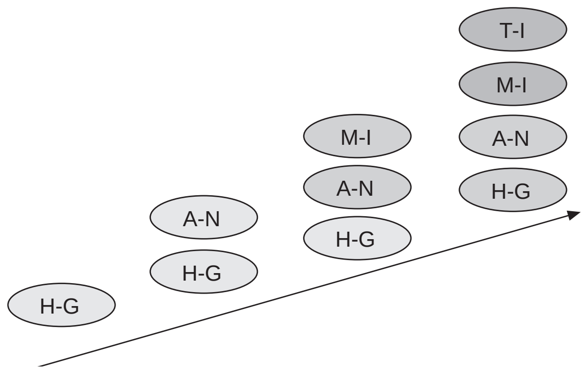


Figure 5: **Linear stratified amalgamated model of civilization development (H-G: Hunter-Gatherer; A-N: Agricultural-Nomadic; M-I: Manufactural-Industrial; and T-I: Techno-Informational).**

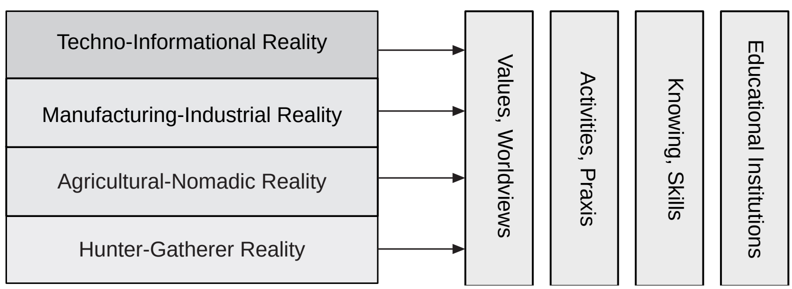


Figure 6: **Each reality holds a respective set of values, worldviews etc.**

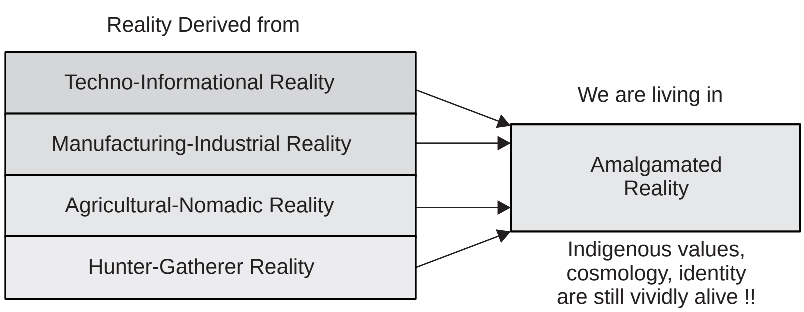


Figure 7: **Amalgamated reality we are living in.**

One of the typical examples of amalgamated reality of contemporary Japanese ways of life is that of fishermen in a lake. They work on boats equipped with engine (M-I), radio (M-I), GPS system (T-I), and fish detector system (T-I). While they have a certain fundamental knowledge of how such apparatus works and they can repair engines, they also have and do utilize indigenous knowledge about wind direction, weather changes, wave changes and fish detection in order to do fishing at the very point of fishing. Such indigenous knowledge is also very critical for their safety on the lake. Fishermen do not care about the origin of this indigenous knowledge, but it is derived from Hunter-Gatherer stage of civilization. So, we can say the total knowledge set they utilize is also 'amalgamated.'

Another example is a business person working at an office in a huge techno-intelligent building located at a certain metropolitan city area. On working days, he/she is enjoying his/her daily work with highly techno-informational tools and equipment. However, a couple of times in a year, he/she can have opportunities to return to his/her rural homeland with family (spouse and kids), where his/her parent(s) are living as farmer (cultivating rice and/or vegetables). He/She helps the parents' in planting rice (in the spring) or harvesting rice (in the autumn), and occasionally enjoys outdoor activities like fishing, hunting, collecting wild mushrooms, berries, and nuts. The business person is, without doubt, living in an amalgamated reality of contemporary Japanese ways of life.

Thus, Indigenous Science is not a past perception of reality, but a present perception (stratified and amalgamated) of reality (with different kinds of precedent values, cosmologies and identities). Such a cultural-historical entity should be learned by the people in general and younger generations in particular who are living there.

The next question needing to be answered is how and where should such Indigenous Science be taught? Fundamentally, two types of treatment will be possible: The first type is Indigenous Science should be treated and/or taught separately from the Western Modern Science (scientists' [science]). And the second type is the opposite way of doing, both should be treated and/or taught simultaneously at certain situations like Japanese Rika classes. I do not think there is a correct answer. It is the teacher's own professional decision and responsibility. It depends upon the political, situational, and cultural contexts and/or those who treat or teach.

If you prefer to teach Indigenous Science alone, because of its broad scope and sequences from curricula contexts, you may choose to develop a new program for other education settings than schooling itself with instruction modes much more appropriate for values education, moral education, identity education and cosmology education than those for school subject teaching including teaching of Western Modern Science. For this purpose, you can invite resource persons like community leaders and elders into the program. Or, you can develop a co-learning program for kids, parents, and grandparents.

On the other hand, if you, as a science teacher, prefer to teach Indigenous Science with Western Modern Science simultaneously in school settings, you need to be prepared for different kinds of instruction modes (for values education, moral education, and identity education etc.) from those for teaching Western Modern Science in advance. It may be a good idea for you to invite other subject teachers to collaborate or cooperate in the developing and teaching processes, especially social studies teachers and moral education teachers. Or, if a peer social studies teacher is trying to include components of Indigenous Science into his/her classes, you as a science teacher can help him/her put certain scientific (Western Modern Scientific) aspects into the learning activities. This is a challenge for you because the subject matter or contents are not selected from the viewpoint of Western Modern Science. Of course, 'treatment of Indigenous Science and Western Modern

Science simultaneously' does not necessarily mean that both should be always treated at all times. The simultaneity happens occasionally when necessary.

Concluding Remarks

As far as I know, India is one of the most multi-ethnic, multi-cultural, and multi-linguistic countries in the world. Vivid reality of respective people with differential socio-economic cultural backgrounds can be extensively explained in the amalgamated reality model (Figures 6 and 7) by changing relative ratios among four civilization components. For example, in the reality of people living in a very rural area, H-G and/or A-N consist of major components, whereas in the reality of metropolitan city area, M-I and/or T-I are major components. One of the most important things in such a multi-cultural society like India is how to maintain and develop simultaneously three different kinds of identity (local identity, national identity and global identity), among the citizens including youngsters in education enterprises (Ogawa, 2008b). Since science and technology is inevitable to serve as one of the key factors in our contemporary society, science education in school settings cannot escape from committing to such identity formation processes. Science educators in collaboration and cooperation with other responsible stakeholders (for example, elders in community, parents in family, religious institutions, media etc.) may be key persons at the community level to hasten the processes.

Notes

1. In this paper, I use the expression, [science] as this superordinate concept in order to avoid its possible misunderstanding as the contemporary science in the popular usage among science educators.
2. Previously, I named this group of objectives 'Shizen education' (Ogawa, 1998, 2002), but since the term, 'Shizen education' can contain much more components than 'Loving Shizen' alone, I will select this specific usage in the present talk.

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DISCUSSION

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Q1: I appreciate the manner in which you presented the possibility of working close to nature and putting together a possibility of amalgamating the so-called western modern science in particular Asian context. So my question is whether training to understand science is an explicit form of understanding, considering that distancing from the subject and the object is a sort of methodological requirement. It could be tentative, it could be temporary, but one could get closer to life situations after distancing oneself for a while. So I want you to reflect as an epistemologist, as I am, as to how to see this as a possibility and also extending this to culture. If it is cultural, then there is also a danger of making more of implicit knowledge and where is the science? Because if you understand science as an explicit form of a knowledge then there is a problem here.

MO: This is a very big question for me. One point is that students as well as we ourselves can live in very many differential ways of life. So we need not force students to only one way of life. Sometimes problems arise because we are asked to select between a scientific or traditional way of life. These two components can co-exist within one person. This kind of message needs to be expressed by teachers. The way a scientist thinks of a phenomenon is quite different from the way students think. These are quite different but both should be appreciated. And under certain specific situation, one could be preferred over the other and then also it is okay as long as it is one's own decision. This kind of multiplicity in life is required otherwise it is very difficult to tackle two different things into one classroom.

Q2: Thank you, this is very interesting, something similar to my understanding. Obviously it is *indigenous knowledge* and you can value it. As far as science is concerned it is clearly defined and the term modern western science is counter-intuitive. So when science is defined, the difficulty comes in naming some science as *indigenous science* as referred to in your description, which I really enjoyed. This view seems to be a more encompassing world-view but any definition is problematic, I would like you to comment on it.

MO: That's a great point, so probably the selection of the term science is problematic. *World view* or may be a *way of knowing* something is much more comfortable for science. Maybe I need to invent a different type of superordinate concept that is much easier for both sides.

Q3: First of all, I would like to thank you for your outstanding presentation. I would like to comment about teacher education, and how to address your ideas in a teacher training programme. Before I started working at Eindhoven University of Technology, I worked with the Indigenous communities in Canada and now am returning to the Netherlands. I wanted to address issues of indigenous knowledge, science and teacher programme, so what I did was to take the notion of alienation from science as a central issue in teacher education. This problem is not only an issue in the teacher community, but is also an issue in Europe as most of the students have become alienated from science. If you take this as the central issue in teacher education and raise it with in-service teachers where most students are not familiar with nature of science, then you can start working with this issue. And it works quite well in teacher education.

MO: Japan is not a good example because it's very homogeneous, and so it is a very unique situation. I would encourage all of you to discuss this point in multicultural communities where probably there are different ideas. That might be a right thing for all of us because in my case, for e.g., just as I mentioned it is a very small teaching community, everything is simple. But probably in a multicultural community a much more complicated procedure is required and one needs to keep watching what is going on in India as well as in the European countries.

Q4: In the talk you mentioned the influence of Confucian Philosophy. Also, in Mathematics education there is a strong East Asian influence of Confucianism. I wanted to ask if there is any influence of Buddhist Philosophy.

MO: One of my colleagues is now working on that interesting point. It is being studied especially for elementary teachers, how their ideas come about. Most of the time he mentioned that it was quite sympathetic with certain kind of Buddhist philosophy. I am not sure what the final results are but anyhow the project is ongoing, so I have no idea now. I think this is a very promising research hypothesis.

Q5: It's just a clarification, these terms *Rika*, *Shizen*, and there is another term for observation so are these part of everyday terms that all Japanese use? Are these terms part of discourse of education? Are they specifically part of the discourse of science education? Are they used explicitly at the primary level, secondary level and higher secondary level? We, in India, have a similar word *Vigyaan* which was also coined specifically for teaching science so maybe it's something similar.

MO: *Rika* means a subject name, *Ri* means reason, *Ka* means subject, so *Rika* is reasoning subject. It was developed in late 19th century but at that time there was no corresponding subject about it so they developed the new subject called *Rika*. At that time even in a university programme there was no such kind of history and probably in late 1990's in the western world a natural history or natural philosophy had already existed, but not in general science so that is a reason why *Rika* is quite useful. Even *Shizen* has two different specific meanings. *Shizen* is a much broader concept and even for education we call *Shizen* sometimes in different aspects. The term *Rika* is quite symbolic. *Loving Shizen* is used for different types of communication with *Shizen* within the domain of Japanese people's ideas.