Understanding the Indigenization and Hybridization of the Science Curriculum: The Model of Culturally Relevant Science Education in Thailand and Japan

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Introduction

Science education in East Asia, both in the preservice teacher preparation and elementary level, is faced with multiple and legitimate challenges in the twenty-first century. In view of the over-importation of Western scientific knowledge and practices in the teaching of science in a non-Euro-American country, which according to Aikenhead (2008, 1) and Zembylas (2005, 709), is a potential recipe for colonization, there is a need for culturally relevant and culturally responsive science education (Ladson-Billings, 1995, 159)—one that is mindful of indigenous knowledge and practices as capitals in the teaching and learning of science.

The overarching goal of this cross-cultural, multi-site ethnographic research project was to generate models of culturally relevant science education through an in-depth understanding of how the indigenization and hybridization of the science curriculum take place in Thailand and Japan. Indigenization, in this study, refers to the "revisioning of cultural landscape from the perspective of indigenous peoples and opposition to colonization through indigenous identity and practices" (Chinn 2007, 8). As an educational strategy and approach, it looks into indigenous knowledge and practices as curricular capitals in the teaching of school science. Thus, the indigenization of the science curriculum makes use of "indigenous science" —the science in a given culture—as curricular capital, which gives preference to the process of generating knowledge based on "indigenous ways of living with nature and the neo-indigenous ways of knowing" (Aikenhead and Ogawa 2007, 540). What statuses do indigenous knowledge and practices hold in school science? What happens when indigenous knowledge and practices are transported into schools and taught to students? Can I find models of science education that draw upon indigenous ways of knowing and doing? If not, in what ways do schools and teachers hybridize their curriculum to accommodate both indigenous knowledge and practices alongside dominant discourses of Western science?

This study was further informed by Barton and Tan's (2009, 52-53) notion of hybridization as an avenue for marginalized knowledge and practices (e.g., indigenous science, local wisdom) to stand alongside Western science in schools. Zembylas and Avraamidou (2008, 977) argue that hybridization opens an opportunity to disrupt and resist any form of colonialism and imperialism in a Western-based science curriculum. The hybrid space provides a "navigational space… to negotiate differing discourse communities" and to destabilize and expand boundaries of official school science (Barton and Tan 2009, 52). The indigenization and hybridization of curriculum, therefore, are two complementary approaches to make science more relevant to the lives of students. I focused on these two approaches as my specific lenses in understanding and generating models of culturally relevant science education in Japan and Thailand.

Methodology

My research project was conducted in Japan and Thailand. I stayed for about six months in each country. I employed the multi-site ethnography as a research methodology. Framing from the epistemological stance of constructionism and the theoretical perspective of interpretivism (Crotty 2003), I utilized the interpretative lens of symbolic interactionism in understanding the notion and practice of cultural relevancy in science education. Specific theoretical underpinnings of the study revolved on assumptions surrounding culturally relevant pedagogy (Ladson-Billings 1995, 159), community funds of knowledge (Gonzalez 2005, 29; Gonzalez, Moll, and Amanti 2005, 29), indigenous science education (Aikenhead and Ogawa 2007, 539; Chinn 2007, 50), and hybrid space/hybridization in science curriculum (Barton and Tan 2009, 50; Zembylas and Avraamidou 2008, 977).

This study was conducted in Thailand from July to December 2011 and in Japan from January to June 2012. In Thailand, I visited 11 provinces/cities and collected data in 6 universities, 12 schools and 16 surrounding villages. The summary of research activities, participants and data/outputs is presented in Table 1.

The second part of the research project was conducted in Japan from January to June 2012. I conducted my ethnographic study in five elementary schools and six teacher preparation institutions in the Kanto, Shikoku and Chugoku regions. The research data collected from research sites included a total of 32 audio records

Setting/Activity	Data/Output	Participant
July-September • Visited 5 provinces/cities: Bangkok, Nonthaburi, Nakorn Nayok, Prachin Buri, Chantaburi and Chiang Mai • Visited/ Collected data in 8 elementary/ middle schools and their surrounding villages and in 3 universities	31 interviews 7 focus group discussions 22 observation notes/ researcher-generated memos about 1000 pictures 45 documents (e.g., syllabi, program of studies, pamphlets, among others) 25 textbooks	• **Interview** - 5 preservice teachers - 3 scientists - 16 elementary/ middle school teachers - 4 science education policy makers - 3 village elders • **FGD** - 2 FGDs with a group of preservice science teachers - 4 FGDs with a group of elementary science teachers and their school officials - 1 FGD with a group of elementary students
October-December • Visited Bangkok, Chiang Rai, Mahasarakham, Loie, Nong Khai, Kalasin, Sisaket • Observed, visited and/ or collected data in 4 schools, 3 universities, and 8 villages	15 individual interviews 5 focus group discussions 18 observation notes/ researcher-generated memos 900 pictures with about 100 relevant pictures annotated 35 documents (e.g., syllabi, programs of study, pamphlets, and other archival/electronic information)	• Immersion in rural communities with two cohorts of preservice teachers (n1=23; n2=20) • Immersion in a school/ community of Buddhist monks, lay persons, and students (n=about 200) • 6 science education faculty members

Table 1. Summary of Research Activities, Outputs and Participants in Thailand

of classes at an average of 45 minutes each, 52 video records of classes at an average of 37 minutes each, 7 tape- recorded formal interviews, over 30 expanded notes, over 2000 pictures, and a wide array of documents ranging from books, courses of study, syllabi, class schedules, among others. Table 2 shows the major research activities and accomplishments in Japan.

What I Learned in Thailand

My major research goal was to draw models of culturally relevant science education in Thailand. In this section, I represent my findings using the Integrated Model of Culturally Relevant Science Education in Thailand (Figure 1).

School/ University/Place	Research Activities/Accomplishments
University A (Host University, Kanto Region)	Arrived and settled in the university; familiarized myself with "ways of doing" in Japan; observed some science classes in the university and served as a resource person in some science and math classes; reviewed the literature, most especially the historical, cultural, and legal bases of Japanese science education; presented findings of the study to graduate students and gathered feedbacks/reactions to validate the results.
University B (Kanto Region) University B Attached Elementary School	Observed elementary science classes in the morning, mostly Grades 5 and 6; observed preservice science teacher preparation classes at University B; generated 16 expanded observation notes, about 12-hour videotapes of classes/inquiry activities, over 500 photographs, and 3 audio-records of interviews conducted with a science teacher, a science teacher educator and a school principal.
University C (Kanto Region)	Interviewed three science teacher educators; did an informal conversation with two graduate and three undergraduate students; observed an undergraduate chemistry class; collected documents (e.g., course of study, National Science Education Curriculum of Japan, Teacher Education Syllabus)
University D (Shikoku Region)	Observed and videotaped preservice science teacher preparation classes, did two paper presentations in seminar classes, participated in research meetings in a science lab, did informal conversations with graduate and undergraduate students, collected documents (e.g., lesson plans, course of study, syllabus), did informal interviews/conversations with two science teacher educators.
University D Attached Elementary School	Observed and participated in elementary science classes in Grades 4, 5, and 6; took video and audio clips of classroom activities; participated in an outdoor eclipse observation session; took lots of photographs of student outputs and class activities; collected documents such as science textbooks and samples of student works
Community Center near University D (Shikoku Region)	Observed a lesson study, videotaped the proceedings and took pictures

School/ University/Place	Research Activities/Accomplishments
University E (Chugoku Region)	Presented two seminar papers to undergraduate students, participated in a research meeting with science education faculty, observed undergraduate science education classes, conducted three informal interviews with four science teacher educators
University E Attached Elementary School	Observed lesson study sessions, collected sample lesson plans, took pictures, did informal conversations with elementary science teachers and teacher educators
A rural elementary school	Observed lesson-study sessions; participated in the critiquing sessions; collected sample lesson plans; took pictures; conducted a focus group interview with the principal, science teachers, science teacher educators, and a graduate student.
Nature Conservation Center	Toured the site; tape recorded some informal conversations with tour guides; took pictures; collected documents such as science inquiry activities, pamphlets, brochures, etc.

Table 2. Major Research Activities and Accomplishments in Japan

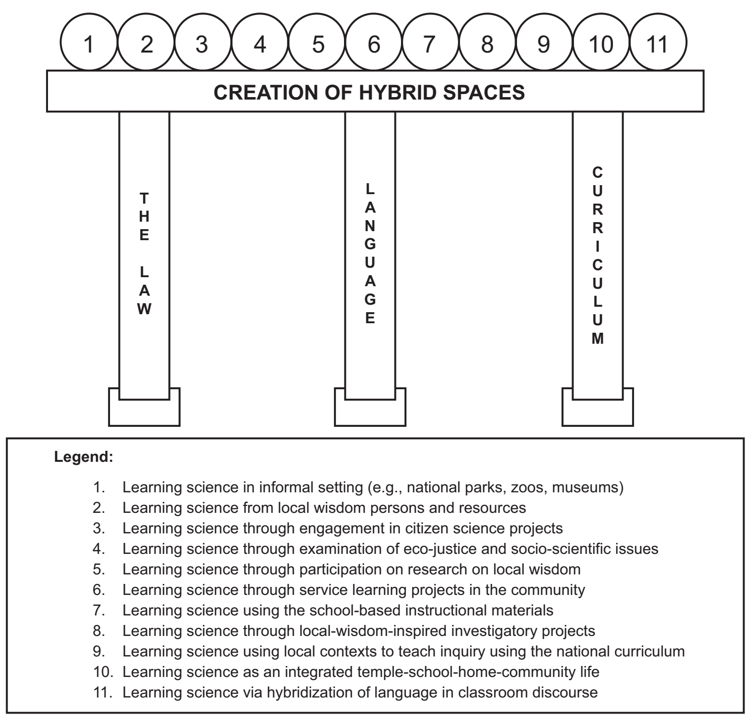

Figure 1. Integrated Model of Culturally Relevant Science Education in Thailand

Elements of Culturally Relevant Science Education in Thailand

There are three major elements which support cultural relevancy in science education in Thailand, namely: the (a) law, (b) language, and (c) curriculum. National in scope, these elements are considered pillars of culturally relevant science education in Thailand because they provide support and enabling mechanisms for the creation of hybrid spaces in school. In these spaces, local wisdom and Western scientific knowledge and practices stand side by side in the teaching and/or learning of school science.

The law. Culturally relevant science education in Thailand is supported by several legal bases. For example, the Thai Constitution and the National Education Act of 1999 provide a solid foundation to support practices toward cultural relevancy in science education. In particular, Section 81 of Thailand's Constitution stipulates that the "State shall promote local knowledge and national arts and culture". It also guarantees the right of the local people to conserve their local knowledge and practices. In addition, Section 46 states that "Persons so assembling as to be a traditional community has the right to conserve or restore their customs, local knowledge, arts or good culture of their community".

In addition to the Constitution, the National Education Act of 1999 (e.g., Sections 7, 23, 24, 25, 27 and 57), supports the utilization of local wisdom in the teaching of science. Section 27, for example, states that "Basic Education shall be responsible for prescribing curricular substance relating to needs of the community and the society, local wisdom, and attributes of desirable members of the family, community, society and nation". The same Act stipulates the creation of the Office of National Policy which issues various statements and outlines strategies in the utilization of local wisdom in schools. This Office has been responsible for the following: (1) the establishment of the Thai Knowledge Council, (2) the establishment of the National Research Institute for Thai Knowledge and Education, (3) the establishment of the Thai Knowledge Fund, (4) the establishment of Teaching and Learning Thai Knowledge; (5) the recognition (e.g. honouring and rewarding) of Thai Knowledge Teachers, and (6) the formation of the Thai Knowledge Information Network System. In summary, culturally relevant science education in Thailand is grounded on various laws, thereby providing enabling mechanisms to support the use of local wisdom in the teaching and/or learning of school science.

The Language. The use of a national/local language is closely tied to the issue of relevancy in science education. This is true in Thailand, where Thai is used as the medium of instruction in the teaching of science, from the elementary up to the graduate level. Furthermore, Thai is the dominant language for academic discourses, both inside and outside the school. Science education in Thailand has accumulated equivalent Thai words or phrases to represent scientific technical terms. Some of these technical terms are already integrated in the everyday language of students. For example, during my observation of a group of students doing a field investigation in a national park, the Thai language was used in all of their conversations and interactions with the resource person. Similarly, technical words to represent science concepts were in the Thai language. I also noticed the same trend in my classroom observations where scientific and technical terms in the Thai language had become part of the normal classroom discourses of students. Thai science education has accumulated technical words to communicate science content and processes. Thus, hybridization via language has taken place through the adaptation of Western scientific and technical terms in the Thai language.

The Curriculum. The School-Based Science Education Curriculum in Basic Education in Thailand allows for a "30% deviation from the nationally prescribed science education curriculum to accommodate 'local wisdom' in schools". In other words, teachers may include 30% indigenous local knowledge (popularly termed as local wisdom in Thailand) in the teaching of science to students in the elementary and secondary levels. In addition to the nationally prescribed textbooks, teachers have also been encouraged to infuse local wisdom in the instructional materials they developed for students coming from local communities.

In the preservice science teacher preparation program, local wisdom is infused in the teaching of Professional Education subjects such as Field Experiences and Classroom-Based Action Research. The local wisdom is also incorporated in science education subjects such as *Local Wisdom in School Science* (as in the case of University B in the North); *Science, Technology Education and Society* (as in the case of University A in Central Thailand); and *Curriculum Development for Local Needs* (as in the case of University C in the Northeast). The inclusion of local wisdom in science content subjects is mostly dependent on the teacher/professor handling the course. A university in the northeast offers interesting subjects under the (its) Science Content such as *Physics for Everyday Life, Household Physics*, and *Survey and Collection of Local Plants*.

In summary, in my observation and analysis of the science education curricula and practices in Thailand, I found some evidences of inclusion of local wisdom in preservice science teacher preparation programs. However, this inclusion has not been systematic and systemic. The integration of local wisdom was mostly determined by a professor's/teacher's commitment, advocacy and experience. I also noticed that in-service science teachers who specialized in or were mentored on the use of local wisdom in science education during their graduate education, were most likely the ones who integrated local wisdom in their teaching of science.

Creation of Hybrid Spaces in Thai Science Education

In the course of my six-month stay in Thailand, I was able to document 11 hybrid spaces in Thai science education. Barton and Tan (2008) consider these hybrid spaces as negotiational spaces; they do not occupy the central position in science education discourses. However, they allow local wisdom to gain entry into the official school science. These are spaces wherein local wisdom stands alongside Western scientific knowledge in science instruction. As shown in Figure 1, hybrid spaces in Thailand are supported by pillars of cultural relevancy—the law, the curriculum and the language. Hybrid spaces are situational, local, and specific. They are present in the learning of a specific subject, in the implementation of a program, or in the enactment of a specific classroom practice. For discussion purposes, I am highlighting three examples of hybrid spaces in this paper, namely: (1) learning science in an informal setting and from local wisdom; (2) learning science through engagement in citizen science projects; and (3) learning science through service learning projects in local communities;

Learning science in informal settings and from local wisdom. Culturally relevant science education in Thailand takes place in various settings, both inside and outside the four-walls of a classroom. "We make use of our local wisdom and resources to teach science in schools", says Tam (pseudonym), an elementary science teacher in the northeast of Thailand. Local wisdom, according to Tam, refers to the "knowledge and practices of our people...; they are tested as effective through continuous use in local communities". During the course of my stay in Thailand, I observed several informal settings (e.g. national parks, farms, forests, zoos, museums, science centrums, etc.) where students learned science. For example, in Pathum Thani Province, an Agri Museum is used to teach students about Thai rice varieties and technologies. The Sirindhorn Museum in Kalasin, on the other hand, has been the setting of geology classes for prospective science teachers. In Bangkok, there are various learning centers and science centrums to help students learn and appreciate science. These resources have been utilized by teachers in their field trips. In one particular university, a science fair was conducted inside the campus. Elementary and high school students observed traditional and emerging technologies in science fairs and exhibits. Students also participated in the science fair by putting up booths and tables to display or demonstrate their science-related products and/or activities. At the university level, a group of preservice science teachers learned the dynamics and interrelationships of organisms in a tropical forest using the national park as the context for learning science. In their bird-watching and safari-night activities, students learned about the behaviors of local animals and linked them to their science lessons.

In addition to the local sites as contexts for learning science, there are numerous sources of "local wisdom" which, according to in-service science teachers and local villagers whom I interviewed, refers to "persons formally recognized by the government as bearers of traditional skills and knowledge". Some of them are "informally known through words of mouth in the village because of their expertise in one or several life skills" (e.g., dying of fabric, making of clay pots, weaving of clothes, producing rock salt).

Preservice science teachers recognize the "knowledge possessed by the local wisdom holders in the village", despite their "lack of [formal] education", because "they work" by "solving real life problems and producing desirable and tangible results". In other cases, local wisdom may take another meaning. Local wisdom also means "local knowledge, to include both "traditional" and "Western scientific knowledge". Local wisdom, therefore, appears in various levels and forms—as traditional knowledge in one end and in the form of Western scientific knowledge, on the other end. Much of this knowledge appears in a hybrid form. For example, in his farm, a famous local-wisdom expert in the northeast applied the Economic Sufficiency Theory of His Majesty the King. The theory has been applied in the agriculture sector, most especially in the production of agriculture-related products. This theory promotes economic sufficiency and prosperity among Thai farmers by encouraging them to produce a surplus of goods. "All I need is in the farm. I produce them…. I can live in this farm without buying much from the outside. I sell the extra in the market", said a local-wisdom holder. Successful and economically self-sufficient, he was accredited by the Ministry of Agriculture as a person possessing local wisdom in the field of farming. Farmers and students come to his farm and learn from his knowledge and practices. I joined a group of preservice science teachers on a one-day trip to the farm of this local-wisdom holder and, together with the students, learned how to cultivate mushrooms; raise chickens, bullfrogs, catfish, ducks, pigs; grow various kinds of vegetables; make organic fertilizers and pesticides; produce biogas; and grow rice and process them into various by-products. I noticed that most of these knowledge and practices exist in hybrid form, with Western knowledge enacted in a local practice. However, some knowledge exists in a highly traditional form. For example, local-wisdom persons teach students how to dye fabrics, make earthen clay pots, weave cloth, and produce salt, among others. In a Chong community, a village herbal doctor served as a resource person, teaching students the names and uses of various forest plants.

Learning science through engagement in citizen science projects. Schools offering basic education are sometimes selected by big universities and/or scientific institutions to become partners in a research project. Scientists from the university engage elementary and/or high school students and teachers, and local village people, in the conduct of a research project. This was the case of a citizen science project, a rich context for examining culturally relevant science education in Thailand. For example, a huge citizen science project took place in a local school in the Northeast. Scientists from a nearby university involved village elders, and high school students and teachers in the documentation of various plants, insects, and mushrooms in the forest located at the back of the school. According to the students and teachers involved in the project, "We were first trained in the university on different aspects of the collection, documentation, and preservation of plants, animals (mostly insects), and mushroom specimens... With the help of village elders, [we] collected, identified, and preserved these specimens.." and then "uploaded their pictures and basic information" [.e.g. local name, scientific name, uses] "in a website maintained by the scientists in the university".

In another elementary school in the north of Thailand, students learned about birds and their behaviour by "engaging in a bird-watching research project". These students "identified and documented various species of birds" found in the community and, in collaboration with their teachers, "created instructional materials" to teach science. This project was made possible through the school's partnership with a science-based, non-government organization involved in the conservation and protection of birds. As an extension of the project, the school principal put up a "bird-watching garden in the school" where students in science classes could "study birds and their behaviour". As part of their inquiry activities in the garden, students made instructional materials related to birds, such as three-dimensional books, pamphlets, fliers, models, drawings and sketches. These outputs were displayed in the school's learning resource center.

Learning science through service learning projects in the community. I had the chance to participate in a science camp for prospective science teachers. The camp was held beside a Buddhist temple. In this camp, students learned science-related practical skills from the Buddhist monks who taught them about the different uses and applications of forest herbs. "We do this project on a regular basis... I have a personal connection with monks in the village. As part of our merit-making activity, we engage our students in making herbal products based from the local wisdom and practices of the monks", said a College of Science dean, who initiated the project. One important dimension of this camp was the "service learning project conducted by prospective science teachers with the local village people". Students worked with local people in the production of a herbal medicine capsule, a herbal shampoo, herbal powder to serve as a substitute for monosodium glutamate (MSG), and a herbal detergent, among others. Students donated to the monks the herbal products they made as part of their merit-making activity. The service learning project was conducted in collaboration with local villagers, who also offered their "service for free in the production of products". In addition, prospective science teachers conducted a simple medical/physical examination of (on) local villagers by determining their blood pressure, height, weight, etc. and computing their obesity index.

What I Learned in Japan

Japan offered a unique experience in my search of a model for culturally relevant science education. I experienced several tensions as a researcher. For example, my initial theoretical framework –that of dichotomizing traditional/local knowledge and Western science—did not work well in Japan. It was difficult for me to locate such distinction from the perspective of my research participants. "Rika"–the school science—was considered Japanese. On the surface, I personally found Rika too Western in content and practice, but my research participants did not and could not locate its Western roots or origin. "Rika is Rika" and "it is Japan's", so to speak.

In the succeeding section, my discussion focuses on the goal of characterizing Japanese elementary schools by examining science teaching and learning practices, and locating their unique qualities with respect to macro socio-cultural discourses in science education, within and outside Japan. I have attempted to answer the following questions: What and how do students learn in elementary science? What are the unique practices in elementary science teaching and learning, in particular, and of the Japanese elementary schools, in general? What do these practices reflect on the socio-cultural dimension of elementary science education?

The findings of my study revolve around three major themes: (a) co-existence of uniformity and individuality, (b) reproduction of scientific knowledge in Rika classes, and (c) education for citizenship training.

The Co-existence of Uniformity and Individuality

Rika, the school science, is characterized by a standardized, national curriculum implemented in a uniform manner across Japan. According to a science teacher educator I interviewed (Researcher's Notes, April 27, 2012), this national curriculum assures "similar objectives and content", including "suggestions on handling the content…[to be] uniformly implemented among school children". Examining the content of the curriculum, I wrote the following descriptions: "very compact and focused…", "not too heavy in science content". Rika follows the spiral curricular model—"topics and content are built and expanded as one moves from one grade level to another". One strong component of the curriculum is the integration of the "love of nature" in "Rika", as reflected in its goals: "To enable pupils to become familiar with nature and to carry out observations and experiments with their own prospectus, as well as to develop their problem-solving abilities and nurture hearts and minds that are filled with affection for the natural world, and at the same time, to develop realistic understanding of natural phenomena, and to foster scientific perspectives and ideas".

Another evidence of uniformity in the science curriculum in Japan is found in textbooks. Textbook development and production are tightly supervised, regulated and controlled. "Writers and publishers are carefully selected", said a science teacher educator (interviewed, May 25, 2012) who participated in the writing of a textbook for elementary students". There are only four "authorized" publishers of science textbooks in Japan. I examined these textbooks and described them in my field notes (May 5, 2012) as "thin, coloured, printed in glossy paper, with less words but more of pictures, not too content-heavy". I also noticed the "positive depiction of science" in the textbooks. I found pictures of children enjoying science. The pictures also depicted science in everyday life, in the natural environment, and in the use of reusable materials such as toy cars, which were used in several experiments; so were styro/plastic cups in activities involving the germination of seeds.

How was the national curriculum enacted in science classrooms? Classroom instruction was directly linked to the national standard and was carefully controlled. Teachers saw to it that the instruction would fit a given time frame. The board work of teachers was also carefully planned, usually at the rate of one board work per session; erasures were discouraged. The board work usually followed a pattern inclusive of the topic, the goal, objectives and/or inquiry questions. The teacher scaffolds took the form of drawings, sketches, the outline of an activity, findings and conclusions. There seemed to be an equal opportunity for students to learn: "same textbooks, laboratory materials, school uniform" (Researcher's notes, June 2, 2012). Every student was given "equal opportunities to shine". Responsibilities were rotated and equal chances to talk or participate in discussions were provided as long as one knew how to wait. Where was the sense of individuality in the seemingly uniform curriculum in Japan? Answers to this question were reflected in my notes after I observed a Grade 6 class:

> There seemed to be a homogenization of learning experiences in the science class. I was looking for a personal space for students to think individually and represent their thinking outside the group activity. I was drawn to science notebooks. Despite the uniform learning within a group activity, I noticed variations in the way students represented their knowledge in their science notebook. Students differed in their drawings, side notes, labels, and sketches, showing an individual, unique way of representing learning from a common activity. The teaching of science content was the somewhat uniform but there seemed to be variations in the ways students represented their learning in the science notebooks.
>
> *(Researcher's Note, February 6, 2012)*

> Students are made to draw from an actual specimen (e.g., fruit of a soybean). I see variations in their drawings. For instance, a student may add elaborations in the drawing like details, personal notes and colors. Students scrutinize the specimen; use a magnifying lens, sometimes a microscope; remove the seeds from their pods; and thinly cut the seed. The macro and micro details of the specimen are recorded in their notebooks...*Although there is an attempt to homogenize learning in science, variations in learning exist in the way an individual student makes sense of his/her classroom experiences.* These variations can be gleaned in the students' representation of learning in their notebooks.
>
> *(Researcher's Memo (May 15, 2012)*

Reproduction of Scientific Knowledge through Rika

The scientific knowledge and skills were reproduced in elementary science classrooms. Science concepts and skills development exercises were embedded within inquiry activities. Students engaged in "thinking like scientists". They "did science", with instructions strongly emphasizing observational skills and experimental design (e.g., controlling and manipulating variables). For instance, I observed classes using a guided inquiry approach in the teaching of science. The focus of the inquiry was: "When the water evaporates, will the salt appear or not?" I observed that the "students did not open their books. They thought and made their own procedure. The teacher provided the scaffold by drawing a sketch on the board….. Students got their materials from the cabinet. Using the teachers' scaffolds on the board, students performed their activities with minimum supervision from the teacher" (Researcher's note, February 2, 2012).

A teacher scaffold is a type of assistance given by the teacher to students so that they can independently perform their inquiry activities. Since science inquiry in Japan is not of the cookbook type, in the sense that procedures are not typically given by the teacher, the students must devise means to answer the inquiry questions. The inquiry questions must come from the students; though the teacher may already have something in mind. Once an inquiry question becomes clear to the students, after the brainstorming, the teacher writes the question(s) and the topic on the board. The topic, usually written in capital letters, is enclosed in angle brackets (<TOPIC>), while the objective of the inquiry is written inside a rectangle. The teacher then facilitates the brainstorming for inquiry questions. Once finalized, the inquiry question is written on the board. The teacher makes a sketch of the set-up or writes an outline of the procedure. During the activity, the teacher moves around to observe and supervise students. Once the activity is finished, students write their entries on a summary table on the board. The student presentation follows, highlighted by an open forum to accommodate questions from the audience. The abovementioned observations are typical of Rika classes in Japan, which science teachers and teacher educators believe to be "effective in the promotion of scientific thinking among young children".

Education for Citizenship Training

> I notice a very strong emphasis on citizenship training in Japan's elementary education. Pupils, at an early age, are trained to become responsible citizens. Elementary education is clearly used as a tool for citizenship training.
>
> *(Researcher's Memo, February 9, 2012)*

I observed four elements of citizenship training embedded in the teaching of Rika in elementary school: Students generally (1) work as a team, (2) are taught to be clean and orderly in doing their tasks, (3) are trained to follow rules, and (4) practice environment-friendly routines. As a rule of thumb, I observed "teamwork" to be a primary context in doing inquiry in science classes, as well as in activities outside the classroom. In Rika classes, students worked together as a team in doing and reporting inquiry activities. Every student played a role in the team activities; nobody was left idle. In my observation note (February 2, 2012), I wrote: "Every student exactly knew what to do in this activity [evaporation of salt water]. Students [a group of three] got their materials from the cabinet. Then, they helped each other in setting up the activity... While one observed, the other wrote and drew his observation in his notebook. Another student prepared the slides for observation. Nobody was idle".

I also observed a strong emphasis on cleanliness and orderliness in Rika classes. Students were trained to be clean and orderly in all that they did. There seemed to be a right way to do things inside the class. They fell in line when they got inside the class and when they got the materials from their laboratory cabinets. At the end of their laboratory activity, students cleaned their materials. Glass wares were washed and dried. Students wiped their laboratory tables. Materials were returned back to the cabinets. The teacher inspected each working table and formally dismissed students when everything was in order. There seemed to be protocols in doing things inside the class; students followed them. For example, before students got inside the school building, they had to deposit their shoes inside a locker and wear a new pair of shoes to be exclusively used inside the building.

I had also an opportunity to observe school activities wherein students were consciously aware of and enacted environment-friendly routines. Upon the invitation of a science teacher (February 9, 2012), I joined a group of students—whom I had previously observed—during their school lunch. I was amazed at the kind of order and discipline they exhibited during lunch. "Two students (male and female) stood in front; they seemed to play the role of hosts". They saw to it that "everyone got their lunch". There were students assigned to serve the food, distribute milk, give table napkins, etc. When lunch was over, "each student began to roll and tie the plastic wrapper, reducing it into a small piece. A small box was passed around; all the wrappers fit inside the box". In the same manner, "they rolled the tetra pack milk containers and reduced them into minute size before depositing them inside a box". I said to myself that this practice possibly explained why waste segregation worked well in Japan; their children were taught such practice in school while they were young.

Reflection on Local Knowledge/Wisdom, Hybrid Space and Science Education

Local knowledge, often called local wisdom in Thailand, comes in various shades and colors. It may appear in a highly traditional form, passed from one generation to another. Its continuous use affirms its intergenerational validity, i.e. having, as it were, been validated in and through practice. Sometimes, local knowledge, which may appear traditional to the village people due to their limited exposure to the Western world, is highly hybridized in form. Western scientific knowledge has found its way into local villages, interfacing with traditional knowledge and practices. Since it has worked in local villages and been found effective through continuous use from one generation to another, it may appear to be part of the local wisdom/knowledge of the community and may easily find its way into science classrooms.

The concept of hybrid space in science education opens an opportunity for Western science taught in classrooms to coalesce with local knowledge, which in itself might be hybridized in form. The hybrid space, a negotiational space for local wisdom to gain entry into the official science, is filled with unsettling tension. Science is a very jealous field; it has its own standards to assess the validity and reliability of knowledge, different from the pathway to validity claims of local wisdom. This paradigmatic clash often limits the entry of traditional local knowledge, with limited scientific basis, in school science. However, hybridized local knowledge may find its entry in school science to be unproblematic, since it has successfully coalesced with local practices in the village.

Conclusion

Thai science education has provided a space where local wisdom and Western science can stand side by side in school science discourses. The law, curriculum, and language of Thailand provide a strong mechanism for the inclusion of local wisdom in science teaching and learning. Consequently, hybrid spaces have been created in schools to accommodate local wisdom and Western science in the teaching of school science. These hybrid spaces occur in citizen science projects, service learning activities, informal settings, in the use of local wisdom resources, and in persons, among others. In Japan, science education is viewed from a more holistic perspective, sans the local knowledge and Western science dichotomy. From the Japanese perspective, Rika, the school science, is infused with love for/harmony with nature and is characterized by the co-existence of individuality within uniformity in the science curriculum. It provides a context for the reproduction of scientific knowledge within classrooms, and uses education as a tool for citizenship training among Japanese school children.

CAVEAT

Inasmuch as I desired to locate my interview data using the language of my research participants, I had difficulty in doing so because I did not speak and understand Thai and Japanese languages. I had to rely mostly on the interpretation of my interpreters, mostly science educators.

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