FORUM

Collaborating on global priorities: Science education for everyone – any time and everywhere

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Abstract Building on the key ideas from Dana Zeidler's paper I expand the conversation from the standpoint that the challenges facing humanity and the capacity of Earth to support life suggest that changes in human lifestyles are a priority. Accordingly, there is an urgent need to educate all humans about some of the science-related grand challenges, such as global warming and wellness. The key is to enact programs that have relevance to all citizens, irrespective of: age, location, language proficiency, economic resources, religion, gender, sexual preference, and level of prior education. Since significant changes are needed in human lifestyles the current emphasis on preK-12 science education needs to be expanded to cover all humans and the places in which education occurs should be everywhere.

I explore the use of a multilogical framework to conceptualize science and thereby transform science education in ways that better relate to priorities of wellness and harmony in the ecosystems that sustain life on Earth. I illustrate the potential of multilogicality in a context of complementary medicine, using three frameworks: Jin Shin Jyutsu, an ancient system of medicine; a diet to reduce inflammation; and iridology. Use of a multilogical framework to conceptualize science provides opportunities for science education to focus on education for literate citizenry (birth through death) and responsible action, connect to the massive challenges of the present, and select content that has high relevance to sustainability, wellness, and well-being at local, national, and global levels.

Keywords curricular relevance • impact of humans • climate change • wellness • literate citizenry • sociocultural perspectives

Educational policies adopted in the United States have for many decades embraced individualism, consumerism, capitalism, and an unambiguous higher value for human life over other life forms, living things over nonliving things, and maintaining American values and lifestyles over alternatives (Bai 2015). Before expanding on Zeidler's analysis of an excerpt from a presentation by Arne Duncan (US Secretary of Education 2009), I set a context with a recent interview with President Obama and a publication in Science authored by William Ruddiman, Erie Ellis, Jed Kaplan, and Dorian Fuller (2015).

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> "I remember when I first went to college in Los Angeles in 1979, the air was so bad that you couldn't go running outside," Obama said. "You'd have air quality alerts, and people who had respiratory problems or were vulnerable had to stay inside. We took action, and the air's a lot better."
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> "There are a whole host of public health impacts that are going to hit home, so we've got to do better in protecting vulnerable Americans," Obama continued. "Ultimately, though, all of our families are going to be vulnerable. You can't cordon yourself off from air or climate."
>
> (Ben Tinker, CNN Website, April 8, 2015).

The comments by President Obama are indicative of genuine concern. His historical view of air pollution in Los Angeles is that 35 years ago it was so unhealthy it was unsafe to go outside and, due to local action, things improved the extent that the differences were manifest. Having made a pitch for local action President Obama acknowledges that public health will be impacted to the extent that "all of our families are going to be vulnerable." This acknowledgment is a concern because the voice is that of the President of the United States. He goes on to remark that; "you can't cordon yourself off from air or climate." Whereas it is pleasing to see the President highlight the importance of addressing inequality and climate change, it seems as if much more is needed than local efforts. Obviously, local efforts are important, and so too is educating the public about the necessity for a global effort to address these problems and more. The magnitude of the problem and the urgency of getting solutions was emphasized by Jeffrey Sachs (2015), who stated, "In short, the world has climate solutions. What it lacks is the time for further delay." (Loc 7289). Sachs emphasized that climate change was not the only element of environmental harmony that needed to be addressed. In addition to climate change he made mention of a staggering array of intertwined challenges including, poverty, overpopulation, mass extinctions, exploitation of the oceans, urbanization, and social mobility. There is much to be done and it is clear that solutions need to be global rather than local (only).

Science education for everyone

Ruddiman, Ellis, Kaplan, and Fuller (2015) note that humans have altered the earth to such an extent that there is a strong case to define a new geological epoch – Anthropocene. Among the environmental changes the authors list are: built environment; conversions of grasslands and forests to agriculture; algal blooms; and smog and siltation of dams and estuaries. Less obvious problems also were listed. These include increases in atmospheric ozone, carbon dioxide, and methane and increasing acidity of the oceans. Although there is disagreement on when to start the epoch – at the start of the industrial revolution, the explosion of the first nuclear bomb, or several thousand years before – there is strong agreement about humans' grave impact on mass extinctions. Humans have left their mark on the planet and only time will tell if their own extinction is already inscribed. Given the pervasive impacts of humanity on all facets of the Earth – the priority for educating the public about the impacts of humans and associated implications for a sustainable future appear never to have been higher. What needs to change about humans is not so much whether they vote for particular politicians based on their science-related policies, but their lifestyles. The human impacts described by Ruddiman and his

colleagues reflect the cumulative effects of human lifestyles. Humans need to radically alter their ways of living their lives now.

For years science educators and policymakers have been lamenting the deplorable state of science education. Thousands of reports have documented a plethora of shortcomings, especially in the US where international comparisons show that the gaps between science achievement in the US and many other countries are persisting. Although the myriad reports, often based on high-stakes, paper and pencil style tests, might not be based on valid measures of understanding science, there is a tendency to accept the evidence that for many students science learning is not at appropriate levels. The policy response is to call a committee together to do a review and make recommendations, usually for the reform of preK-12 curricula. Efforts at remediation are directed mainly at preK-12 schooling. If decades of testing have any legitimacy, then the implications for the US population may be profound. To what extent is the US population scientifically literate? Do citizens possess the knowledge to function locally and globally in appropriate and responsible ways to build and sustain wellness and well-being of the planet? Furthermore, in light of research on climate change and global warming, are US and global citizens able to collaborate to restore disharmonies that have been created by human lifestyles?

While acknowledging the importance of assessment, my position is that it must take account of the immanent critique, that no matter how extensive and intensive the efforts of assessors, any endeavor to assess what is known will fall short of that mission. Instead of placing primacy on assessment and associated systems of accountability, I advocate for the design and immediate use of a system that acknowledges an epistemology of "knowledge as enactment," embodied, and transcendent. Windows into what is known can be found in the fleeting singularity of enactment, realizing that enactment is multimodal and extends beyond what can be spoken, written, and observed. Simply put, too much happens in the moment for any collective to take note of all that is available to be noticed.

In this paper I use a vertical bar (|) to show a dialectical relationship between the two constructs either side of the bar. In this case, agency and passivity coexist as part of a whole, with each presupposing the existence of the other. Changes in agency are associated with changes in passivity and vice versa.

To be aware it is necessary for an individual to be tuned in to notice the particulars of enactment. Consistent with an agency | passivity relationship (Roth 2007), an actor might notice whether particular practices he/she was looking for occurred and he/she might notice things that happened that were not on the list of what was to be observed. During a selected interval of time much more happened (i.e., much more was known) than was noticed and even more happened that could not be noticed because the observer's antennae were not tuned in to detect everything that happened. Accordingly, systems built around assessments, such as those that hold individuals accountable for scores obtained from assessments, efforts to align the curriculum based on what can and will be assessed, and policy frameworks that orientate STEM to the improvement of assessment scores are potentially hegemonic and highly questionable. New foci are needed for the development of curricula, accountability, and policy formulations.

Now, consider some text from Secretary Arne Duncan's speech (Duncan 2009), excerpted by Zeidler.

> To move this work forward we need to build new curricula and use extended time to make science more interesting and relevant…We need all of our citizens to think about ways to increase fuel economy standards for cars and trucks so they will get better mileage and reduce the nation's dependency on fossil fuels…And we need teachers who have the deep content knowledge of the STEM fields and the passion for teaching our children to prepare them to be the next generation of engineers, scientists, mathematicians, and leaders for technological innovation. (Duncan 2009).

For the purposes of expanding dialogue in this Forum, I identify four issues from the excerpt reviewed by Zeidler: design new curricula to make science interesting and relevant; reduce dependence on fossil fuels; educate and recruit teachers with deep knowledge of STEM and passion for teaching; and produce a new generation of engineers, scientists, mathematicians and technological innovators.

Science curricula that include foci on interest and relevance

A declared interest in expanding the foci of science curricula to include student interests and relevance have the appearance of being the right thing to do at the right time. However, a look at the history of science education, together with a global view, suggest there is nothing new in what Secretary Duncan is proposing. In fact, as I pointed out elsewhere (Tobin 2011), similar recommendations usually find their way into calls for the reform of science education. However, what is most valued when it comes to science education and what is included in the reform documents? For the most part the comparative value assigned to promoting interests and making the curriculum relevant to real life experience has low value compared to learning science content and doing well on mandated achievement tests.

There seems little doubt that changes in science curriculum are little changed in relation to the growth of science. Not only has the content taught in science courses remained much the same, but so too have the approaches used to teach science. As Hurd (1998) famously noted, repeated calls for reform, formulated by official high-level task forces bore an uncanny resemblance to one another and did not catalyze reform. Instead, the status quo seems to have been sustained by political forces that may be scaffolded by business models grounded in neoliberalism (Carter 2010). Curricula across the spectrum of pre-K through college are contested projects and despite the career long endeavors of highly talented science educators, across numerous generations, the status quo seems to be maintained. Consider the possibility of putting greater effort into providing all citizens with a science education in institutions that have not traditionally been a focus for science educators and science education.

I argue that interest and relevance are necessary, but by no means sufficient criteria for curriculum selection. Rather than being perceived as a knowledge system that is impersonal/detached, irrelevant, and removed from the social lives of the global community, it is important that science is unmasked to show its central human elements. Instead of being considered a monolithic discourse, science might be viewed in relation to overarching goals such as sustainability, harmony, and restoration. The connection

should not only be to humanity (or Americans) but also to all living things and complex, interactive webs that sustain the well-being of the universe. Attention needs to be turned to reversing the breaches of stability in ecosystems and related problems, including mass extinctions, climate change, and privileging of human lifestyles within frameworks that reify capitalism, neoliberalism, and competition.

Hegemony is a powerful construct that addresses a disadvantaged subgroup recognizing their disadvantage but regarding it as a normal condition of social life. Accepting meritocracy as a response to the experienced disadvantage is to acknowledge personal responsibility for success. Also, accepting disadvantage can serve as a deterrent to change when those identified as possessing deficits accept them instead of advocating for themselves in terms of what they can and do contribute to society. If STEM is seen mainly in terms of preK-12 education and is focused on preparing the next generation of engineers, scientists, engineers and technologists then the key question that can be asked concerns the possibility of disadvantages to society in global terms. Beyond society, it also makes sense to ask questions about the wellbeing of the planet vis-à-vis the practices of humanity. Is there a case for changing human activity in ways that build, maintain, and restore ecosystems to sustain the planet and preserve its well-being?

Educating all citizens to be literate in science as it relates to global warming

Secretary Duncan switches focus from K-12 education to education for all citizens. In so doing he addresses two aspects of President Obama's policy platform – to reduce US dependence on foreign energy resources and their dependence on fossil fuels. As scholars such as Sachs (2015) have noted, these and many more priorities are among the grand challenges humanity must face now if the problems of global warming are to be met in a satisfactory way. Since Secretary Duncan's speech, six years have passed and the urgency for educating the public on these issues, and more, is even stronger than it was. Importantly, science education needs to go far beyond heightening awareness and creating political infrastructure. There is need for a change in lifestyles so that human actions do not exacerbate problems. Furthermore, changes need to be global. Although local action is necessary for global change, it is essential that massive human population centers (e.g. China, India) also receive adequate effective science education and change human lifestyles now. The time for global change is now and the necessity for science education and science educators to change direction has never been stronger – changing global lifestyles for all humans is a priority for immediate action.

Science teaching

Zeidler raises a question of knowledge of STEM and whether it is feasible for science teachers to have a working understanding of all STEM fields. How would it be possible? Why would it be desirable? In my case, I begin teaching with a weak background in science – and yet in many respects I regard my initial years of science teaching as my most successful. I taught grades 8 to 10 in what was a "science for all" general science course that extended across all three grade levels. The course consisted of four-week modules focusing on different topics within the areas of chemistry, physics, biology, and geology. What was most important to me was understanding the subject matter I was to teach and how to teach it.

During the decade in which I taught high school science and mathematics I completed a bachelor's degree with a double major in physics and mathematics and a graduate degree in physics. The focus was sharply on physics and mathematics, with only one supporting course in chemistry and no biology or earth science. Importantly, I felt that I had the resources to study and learn any area of science I needed to know. I was confident I could access textbooks and journals, attend seminars, and engage in dialogues with scientists. As well as physics, I taught biology and chemistry computer science courses at senior high school levels. Although I readily acknowledge my graduate-level studies of physics were narrow, I was successful in graduate-level studies in ecology and astronomy (graduate courses for science majors) when I undertook a doctoral program in science education. I contend that teachers can and will access resources to be prepared to teach assigned courses. As readers who have taught will attest, there's no better way to learn a discipline than to teach it. Learning in a discipline is ongoing and continuous and it is not helpful to think of subject matter knowledge in a dichotomous fashion of qualified or not qualified to teach.

Secretary Duncan's enthusiasm for educating and recruiting teachers who can teach science with passion is highly commendable. No doubt such a mission can be successful. However, turnover of teachers, especially in urban schools, is one of the greatest policy crises we face at the present time (Ingersoll 2001). There are critical problems associated with the economic costs of educating science teachers who leave the profession within the first few years of teaching. Simply put, science teaching, especially in urban schools, is hard work, especially given the context of assessment driven curricula and accountability systems. It would not be at all surprising to find that teachers who come to schools with passion to teach science lose passion quickly and either leave the job or stay on with feelings of resentment about constraints that prevent them from doing meaningful work in times of crisis.

A new generation of engineers, scientists, mathematicians and technological innovators

There is no dispute with the goal of educating the next generation of engineers, scientists, mathematicians, and technological innovators. The preK-12 school system needs to accomplish that goal not only nationally but also globally. However, there are other pressing goals for preK-12 schooling and beyond. It should be recognized that only a small fraction of the total population will want or need to become engineers, scientists, mathematicians, and technologists. In contrast, all will be citizens of the world and their lifestyles will directly involve science, and impact one another and the Earth. To sustain the Earth and ecosystems that involve humans, humans must change lifestyles to build, sustain, and restore harmony. To afford this process, science educators need to implement science for citizenry programs everywhere, targeting all humans on the birth through death continuum at every moment.

Science educators can expect pushback when they seek to expand conceptualizations of the nature of science to incorporate socioscientific issues and knowledge systems that have been excluded from science, possibly based on deficit laden judgments. For example, knowledge systems such as acupuncture are often dismissed as non-scientific because, in a comparison with Western medicine, they fall short. The criteria for dismissal revolve around what they do not do as well as Western Medicine – not what

they do as well or even better. Rejection of an entire knowledge system leads to marginalization and eventually a loss of empirically validated practices (i.e., practices that work). Adherence to dichotomous ways of thinking that employs all or nothing comparisons, and rejection of entire knowledge systems, reflect scientism as an ideology and acceptance of some of the tenets of crypto-positivism (Kincheloe and Tobin 2009), such as reductionism and monosemia. Incorporating more of what works might pave the way forward in addressing thorny questions about human lifestyles, sustainability, restorative practices, wellness, and well-being.

Re-Visioning science education

Sociocultural perspectives on learning

A direct consequence of considering learning as cultural enactment is that all production (here theorized as reproduction | transformation) is considered learning (Sewell 2005). Accordingly, science education (i.e., production) can occur everywhere and at every moment. As individuals go about their lives they continuously learn from their experiences, including interactions with others and social artifacts in their lifeworlds. Are there parts of this vast reservoir of accumulated knowledge that are science like? From a sociocultural perspective there are many ways of representing scientific knowledge rather than being aware of and recalling science facts on demand. When high value is given to performance on written tests of science knowledge an unintended consequence is to focus enacted curricula on doing better on written tests – greatly distorting school science and contributing to its lack of relevance to social life. Arguably science curricula would be much different if an axiological imperative were to enact science and social life in ways that sustain the planet and thereby enhance the quality of life for all citizens.

If social fields are considered as Sewell (1999) suggested, as having weak or no boundaries, then it is surely time to consider learning in more holistic ways, referenced to lifeworlds, rather than a historical tendency to look within institutions (such as science classrooms), tacitly assuming strong field boundaries that theorize learning as being causally connected to what happens inside the institution (i.e., the science classroom). Adopting a metaphor of magnetic, electric, and gravitational fields, considered as being unbounded; it seems prudent to consider learning in terms of structures penetrating from all fields associated with individuals' lifeworlds. Adopting what Gene Fellner (2014) referred to as a multilectical perspective, it is important to consider that individuals do not check their lifeworld experiences at the door when they enter a classroom, for example. Instead their minds and bodies continue to participate in many fields simultaneously, unless focused efforts are made to "be in the moment" and unattach to other thoughts and associated emotions (i.e., to become and remain mindful; (Powietrzynska, Tobin, and Alexakos 2015)). Hence, in looking at learning in a museum or a school it seems essential to consider macro, meso, and microstructures from a plethora of fields such as home, hobbies, religion, media, recreation, health, politics, and prevailing economic circumstances.

In making this suggestion I am not implying that studies of learning in a museum or a classroom are futile – just that what is learned needs to be carefully connected to the ecosystems in which lives are lived. It goes without saying that what people can do in a

museum, i.e., their unfolding actions, derive from their histories of being in their lifeworlds. The art of researching learning is to open windows into salient fields and identify structures, such as narratives, that contribute to an expanding hermeneutic project that frames doing research. It seems unlikely, and perhaps impossible, to engage in such a project without accessing and learning from multiple voices and meaning systems. Necessarily, what is learned is contingent, emergent, nuanced, and complex. Learning from difference is at the core of such a project.

Collaborating to learn

One of the major challenges faced by humanity is effectively communicating with others across social categories such as: gender, age, race, ethnicity, native language, religion, social class, sexuality, and available economic capital. On any given day differences in social labels are associated with myriad forms of violence on a global scale. There is an imperative for all citizens to learn how to effectively communicate in dialogues that involve participants who differ from one another starkly.

It is almost 20 years since Wolff-Michael Roth and I instigated coteaching and cogenerative dialogue (i.e., cogen) as part of a program on learning to teach (Roth and Tobin 2002). Since then hundreds of studies have examined aspects of cogen as a part of science inquiry (i.e., dialogic inquiry). Cogen requires participants to respect and learn from one another, and view difference as a resource for learning. The number of participants in cogen varies from two to an entire class. Selection of participants depends on the purposes of the cogen, but usually conscious efforts are made to maximize the social differences between participants. Individuals have to adapt their cultural resources to communicate effectively and accomplish whatever the goals of the cogen happen to be. The necessity to produce new culture and be adaptive to others is an extremely important skill for success in an increasingly diverse world in which difference is so often a resource for misunderstanding, conflict, anger, and even hatred fueled violence.

Radical listening is an important skill that is associated with learning with others (Tobin 2009). Radical listening has the goal of fully understanding others' perspectives and their affordances (Kincheloe 2015), and without arguing against them or comparing them with alternatives. That is, listeners seek to suspend judgment as they focus on making sense and realizing the affordances of another's perspective. To practice radical listening is an example of mindfulness, of being in the moment with focus on the train of others' speech. Whereas the immediate goal of radical listening is to make sense and fully explore possibilities of a particular perspective or set of perspectives, there comes a moment when dialogue is necessary to clarify, seek elaboration, and expand the line of thinking that has been laid out (i.e., to make that line even more productive). Subsequently, comparisons can examine the relative advantages of what has been proposed with alternatives, with participants in the dialogue being afforded respect, as their contributions also become foci for radical listening.

Of course context is important and sometimes circumstances will warrant an interruption of a speaker. Whether to interrupt is a matter of practical wisdom, a judgment call that action may be necessary. Right speech addresses a necessity for all participants in dialogue to exercise moral judgment and speak out courageously when speech and others' actions are socially violent. If a listener is convinced that social

injustices are present in another's speaking then there is a moral imperative for him/her to intervene to prevent social violence.

Another aspect of collaborative learning is for peers to participate in coteaching (Tobin and Llena 2011). Since coteaching can take many forms, it is possible to fully utilize participants in a class so that they teach others, and thereby enhance their understandings of what they are teaching while teaching others (Tobin and Roth 2006). Participants might coteach with peers, teach one or more peers as a solo teacher, and coteach with the official class teacher – thereby serving as resources for peers who are seeking to learn. Symmetrically, learning environments can be established so that any person seeking help can approach peers and/or the official class teacher to receive assistance with his/her learning. Through the lenses of a teaching | learning relationship there are many possibilities for thinking of collaborative teacher and learner roles.

The possibilities of multilogicality

Multilogicality (Kincheloe 2010) is an approach to research that employs multiple theoretical frameworks to reap the value of polysemia – that is, the value of social life being characterized by multiple truths concerning what is happening and why it is happening. When different theoretical frameworks are used to illuminate social life, we see different things (Tobin 2008). Accordingly, distinctive questions can be raised and different solutions, which reflect the questions asked, can be obtained. Theories included in a multilogical set are not considered as social truths as much as they are regarded as viable; potentially useful in providing insights into social life and thereby opening up possibilities for changing lifestyles.

Complementary medical fields

Consider healthcare in the United States, which is orientated toward an individual paying for treatments to remedy problems that occur. Western medicine is elevated above other knowledge systems that might also address health problems, for example that involve diet and forms of self-help to maintain wellness and address health projects as they arise, instead of ingesting pharmaceuticals to resolve or control illness when it occurs. What are the strengths of different approaches to wellness? Instead of labeling alternative approaches as quackery, as is frequently done with iridology (http://en.wikipedia.org/wiki/Naturopathy), an agenda for science education might include studying the efficacy of different knowledge systems, such as iridology (Jensen 1980), acupuncture (Kaptchuk 2000), inflammation quieting diets (Abascal 2011), and a plethora of Chinese medicines (Kaptchuk 2000). In many cases knowledge systems such as these have traditions grounded in other countries and are supported by the evidence of practice – rather than clinical trials and case studies that Western medicine expects as part of a peer review legitimation process. There is a tendency to evaluate alternative methodologies using tenets from mainstream knowledge systems rather than the tenets of the system being evaluated. Such a process can highlight shortcomings/deficits as perceived through mainstream lenses rather than affordances that might not be visible from within the mainstream. For example, treatments of diabetes 2, a major problem of Western life, are distinctive using different knowledge systems. A question for science educators to ponder is whether alternative knowledge systems can be used in an

integrative and complementary fashion to resolve some of the problems facing wellness and a medical system that is costly and somewhat inaccessible. To what extent can science education prepare all citizens to know their bodies, identify health projects as they arise, and focus on regular interventions to avoid breakdowns in wellness?

Benefiting from a multilogical approach to wellness: A personal narrative

I developed chronic injuries through overuse and misuse of my leg muscles in sporting activities. Basically, the muscle systems from both knees down became tight, even when I was walking, producing stress on the Achilles tendons and eventually micro tears occurred in both tendons. This injury made it virtually impossible to walk at a reasonable pace for any length of time. Over more than two decades I sought treatment from a variety of medical practitioners and massage therapists. To no avail, the injuries remained chronic. Most medical practitioners I approached suggested I avoid activities that created the pain in both Achilles tendons – walking! In 2012 I obtained treatment from a doctor who specialized in treating professional athletes. He performed platelet injection therapy on the worst of my Achilles tendons and after a couple of months he declared the treatment a success. When I protested that the tendon seemed relatively unchanged he declared that he "would not further treat a healthy tendon."

I identified an acupuncturist who was confident she could repair both injured tendons and associated problems that she traced over my entire body. The differences in the approaches adopted by the sports specialist and the acupuncturist were striking. Essentially the sports specialist was "hands off." He extracted the platelets, injected the tendon, took some pictures, and declared success based on his review of an MRI and a visual inspection. In contrast, the acupuncturist listened carefully to my stories about my health, felt any areas I identified as sore, and then placed needles based on her knowledge of the salient meridians and the flow of Qi through them. She used her fingers to feel along flow lines and especially around acupuncture points that she knew were related to my health projects. She felt for blockages and when she found them she inserted and twisted the needles to release Qi. She electrically stimulated the needles for approximately one hour for each treatment. Within a treatment period of once a week for about six months the Achilles and associated leg muscles were healthy and I resumed playing active sports. Within a two-year interval the acupuncturist took on, and helped to heal, high blood pressure, a damaged coccyx, food allergies, and a variety of minor projects that arose on a week-by-week basis (e.g., back and shoulder pain, body rashes, and stress reduction).

Based on our research on emotion and wellness, undertaken in urban schools in New York City, we became aware of potential health projects experienced by teachers and students (Tobin, Powietrzynska, and Alexakos in press). Accordingly, we designed interventions to increase mindfulness in science classes, including breathing meditation, and the use of heuristics designed to heighten awareness of characteristics we thought would foster science learning. Basically, we needed interventions to ameliorate excess emotions, especially anger, fear, sorrow, and happiness. When excess emotions were prevalent, learning environments often became dysfunctional and stayed that way for an entire class period. Also, there was evidence that the stress of teaching and learning was catalyzing poor health among teachers and students (Tobin and Llena 2014).

In a search of ways to ameliorate emotions, I considered reflexology and in the process of learning about it I came across Jin Shin Jyutsu (JSJ; https://www.jsjinc.net), which I considered to be ideal since it did not involve needles, removal of clothes, or pain (Burmeister with Monte 1997). I decided to seek training in JSJ by the faculty from the national headquarters. My first JSJ class was at the cancer center of the Morristown Medical Center[1]. Interestingly, a recent YouTube video shows a brief the vignette about JSJ being used as a complementary medical practice at the Markey Cancer Center in Kentucky[2]. The inclusion of JSJ in major US hospitals is a sign of growing acceptance of different medical systems as complementary.

I am now certified in JSJ and so is Konstantinos Alexakos, a science educator from my university. Together we have collaborated on studies to show that JSJ touches and holds are used in all facets of social life as individuals re-harmonize bodies that are disharmonized by poor health or excess emotions. Also we have developed new meditation routines involving sequences of JSJ holds (i.e., flows). Finally, we are developing toolkits that can be taught to citizens, including prospective and practicing teachers, and people from a variety of walks of life, who vary in age and lifestyles.

Any health problem can be treated with JSJ and people with wellness projects can use self-help to administer many flows. I have been studying the treatment of a number of projects that include emotional and physical symptoms such as diabetes 2, panic attacks, allergies, high blood pressure, and muscular, ligament and walking dysfunctions. In Figure 1 I am administering JSJ to a co-researcher who has diabetes 2. Through JSJ we can diminish blood sugar by approximately 35% in a one-hour treatment. However, the complete treatment of diabetes 2 appears to need a change in lifestyle, especially diet. The Abscal diet (Abscal 2011), designed to "quiet inflammation," provides confidence that a person with diabetes 2 can control blood sugar without the need for insulin and other medication. We regard JSJ and the Abscal diet as complementary to Western medicine.

<<Insert Figure 1 about here>>

Since I came across JSJ I have been studying the knowledge system intensively, using self-help on a daily basis, and receiving treatments in New York City from a person whom I regard as extremely knowledgeable and a first rate practitioner. I view the treatments as part of my continuous learning program – I learn at the elbow of a master practitioner who also is a master teacher. The regular approach to JSJ is to identify disharmonies through reading of the pulses prior to the treatment getting underway. During my first treatment I was caught unaware by a multilogical approach used by my teacher – an approach that began with iridology. He explained that it makes no sense to use just one methodology. Within 15 minutes my teacher analyzed left and right eyes and began to teach me what to look for and how to see through the lenses of iridology. My medical history, and I suspect its future, rolled out before me. I was then directed to the massage table for a one-hour JSJ treatment that involved multiple pulse readings and flows. Finally I was given JSJ self-help as homework to be done every day and a diet to

[1] http://www.atlantichealth.org/simon/our+services/additional+resources/support+services/integrative+medicine+programs

[2] See links at https://www.jsjinc.net/pagedetails.php?id=articles&ms=8

reduce inflammation. In this case at least three knowledge systems comprised a multilogical system that was an alternative to Western medicine (that regarded me as healthy).

This multilogical approach to medicine serves as an example of ways in which science educators can expand the scope of what is included in science education. It seems useful for individuals to be able to monitor their health proactively, and as problems arise, to administer treatments to themselves and others. Teaching JSJ and complementary practices such as the Abscal diet can help to address some of the big label health projects such as diabetes 2 and obesity together with myriad ailments that arise daily – such as allergies, tinnitus, stiff neck, sore hip, carpal tunnel, headache, hiccups, stress, blood pressure, and palpitations. Similarly, teaching forms of meditation and other knowledge systems that can be used to maintain wellness can be part of the roles of science educators.

The time for change is now

Dateline May 22, 2015: Devastating flash floods in Sydney, Australia and three huge masses (described as blobs) of hot water that are threatening marine ecosystems, and contributing to drought conditions on the West coast of the US. Today's news is unique in its specifics but it is part of a familiar pattern. Extreme weather seems to be an everyday affair nowadays and as a population we need to know more about the patterns, the phenomena, and what roles humans have in the creation of the problems. More to the point, we need to educate citizens about what they might do to restore conditions of harmony in a complex maze of relationships that provide the foundation for stable ecosystems.

For science educators the time to change and expand roles as teachers and researchers is now. Importantly it is essential to initiate new roles based on the needs of a global citizenry when major issues need to be addressed. From climate change, to obesity, diabetes 2, Alzheimer's disease, and cancer, there are needs to educate citizenry at all times and in all places so that they can change lifestyles proactively and avoid calamity. Educating the citizenry to identify salient disharmonies and take actions to restore and maintain harmony has the appeal of common sense – to act locally to resole problems that threaten life, not just at the local level, but also on a global scale. Use of a multilogical approach to identifying projects to be addressed through teaching and research is a way to proceed that should not be encumbered by the actions of scientists, politicians, and colleagues. The time for change is now.

References

Abscal, K. (2011). The Abscal way: To quiet inflammation for health and weight loss. Vashon, WA: Tigana Press.

Bai, H. (2015). Peace with the earth: animism and contemplative ways. *Cultural Studies of Science Education, 10,* 135-147. doi:10.1007/s11422-013-9501-z.

Burmeister, A., with Monte, T. (1997). *The touch of healing: energizing body, mind, and spirit with the art of Jin Shin Jyutsu*®. New York: Bantam Books.

Carter, L. (2010). The armchair at the borders: the "messy" ideas of borders and border epistemologies within multicultural science education scholarship. *Science Education*, *94*, 428-47. http://dx.doi.org/10.1002/sce.20323

Duncan, A. (2009). Secretary Arne Duncan's remarks to the President's Council of Advisors on Science and Technology. Retrieved on April 20, 2015 from http://www2.ed.gov/news/speeches/2009/10/10232009.html

Fellner, G. (2014). Broadening our lenses of perception to advance learning: An introduction to multilectics. *Teaching and Teacher Education, 37*, 169-182. doi: 10.1016/j.tate.2013.04.015

Higgins, M. (1988, March/April). An interview with Mary Burmeister, Master of Jin Shin Jyutsu. Yoga Journal, *79*, 24-29.

Hurd, P. D. (1998). Scientific literacy: new minds for a changing world. *Science Education*, *82*, 407-416. http://dx.doi.org/10.1002/(SICI)1098-237X(199806)82:3<407::AID-SCE6>3.0.CO;2-G

Ingersoll, R. (2001). Teacher turnover and teacher shortages: An organizational analysis. American Educational Research Journal, 38, 499–534. http://dx.doi.org/10.3102/00028312038003499

Jensen, B. (1980). *Iridology simplified: An introduction to the science of iridology and its relation to nutrition* (5th edition). Summertown, TN: Healthy Living Publications.

Kaptchuk, T. J. (2000). *Chinese medicine: The web that has no weaver.* London: Rider.

Kincheloe, J. L. (2010). *Knowledge and critical pedagogy: An introduction*. Dordrecht: Springer.

Kincheloe, J. L., & Tobin, K. (2009). The much exaggerated death of positivism. *Cultural Studies of Science Education*, 4, 513-528. DOI 10.1007/s11422-009-9178-5.

Powietrzynska, M., Tobin, K., & Alexakos, K. (2015). Facing the grand challenges through heuristics and mindfulness. *Cultural Studies of Science Education*, *10* (1), 65-81. doi:10.1007/s11422-014-9588-x

Roth, W-M., & Tobin, K. (2002). *At the elbows of another: Learning to teach through coteaching*. New York, NY: Peter Lang Publishing.

Ruddiman, W.F., Ellis, E.C., Kaplan, J.O., & Fuller, D. Q. (2015). Defining the epoch we live in: Is a formally designated "Anthropocene" a good idea? *Science*, *348*(6230) 38-39. DOI: 10.1126/science.aaa7297

Sewell, W. H. Jr. (1999). The concept(s) of culture. In V. E. Bonell & L. Hunt (Eds.), *Beyond the cultural turn* (pp. 35-61). Berkeley, CA: University of California Press.

Sewell, W. H. Jr. (2005). *Logics of history: Social theory and social transformation*. Chicago: University of Chicago Press.

Tinker, B. (2015). President Obama, others link climate change to public health. Retrieved April 8, 2015, from http://www.cnn.com/2015/04/08/health/obama-climate-change-public-health/index.html

Tobin, K. (2009). Tuning into others' voices: radical listening, learning from difference, and escaping oppression. *Cultural Studies of Science Education*, *4*, 505-511. DOI: 10.1007/s11422-009-9181-x.

Tobin, K. (2012). Sociocultural perspectives on science education. In B. J. Fraser, K. Tobin, & C. J. McRobbie, (Eds). *The international handbook of research in science education* (second edition) (pp. 3-17). Dordrecht: Springer. http://dx.doi.org/10.1007/978-1-4020-9041-7_1

Tobin, K. (2015). Qualitative research in classrooms: Pushing the boundaries of theory and methodology. In K. Tobin, & S. R. Steinberg, (Eds). *Doing educational research: A handbook (second edition)*. (pp. 33-75). Rotterdam, NL: Sense Publishing.

Tobin, K., & Llena, R. (2011). Producing and maintaining culturally adaptive teaching and learning of science in urban schools. In C. Murphy and K. Scantlebury, (Eds). *Coteaching in international contexts: Research and practice* (pp. 79-104). Dordrecht: Springer.

Tobin K., & Llena R. (2014). Emotions as mediators of science education in an urban high school. In K. Tobin, & A. A. Shady (Eds). *Transforming urban education: Collaborating to produce success in science, mathematics and technology education* (pp. 201-218). Rotterdam, NL: Sense Publishing. http://dx.doi.org/10.1007/978-94-6209-563-2_13

Tobin, K., Alexakos, K., & Powietrzynska, M. (in press). Mindfulness and wellness: Central components of a science of learning. *Innovación Educativa.*

Tobin, K., & Ritchie, S. M. (2011). Multi-method, multi-theoretical, multi-level research in the learning sciences. *The Asia-Pacific Education Researcher*, 20(3), 117-129.

Tobin, K., & Roth, W-M. (2006). *Teaching to learn: A view from the field*. Rotterdam, NL: Sense Publishing.

Author Biography

Kenneth Tobin came to the Urban Education doctoral program at the Graduate Center of CUNY in the fall semester of 2003. Prior to that he had positions as tenured full professor at Florida State University (1987 to 1997) and the University of Pennsylvania (1997 to 2003). Also, he held university appointments at the Western Australian Institute of Technology (now Curtin University), Mount Lawley College and Graylands College (now Edith Cowan University).

Prior to becoming a university science educator in Australia in 1974, Tobin taught high school physics, chemistry, biology general science, and mathematics for 10 years. He began a program of research in 1973 that continues to the present day – teaching and learning of science and learning to teach science.

Figure 1. Administering a JSJ flow.