Place-Based Science Learning as Universal Design:

Increasing Access to Science Learning through Study of Shared Places

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Abstract

This multi-site, cross-cultural review of place-based studies conducted by the author, Thai, Chuukese, and Taiwan colleagues explores the question: Does place-based science education meet key criteria of universal design for learning (UDL)? Different cultures, languages, locations, and ages of students provided an opportunity for cross-case, cross-cultural analysis of impacts on student learning with implications for curriculum development and teacher education. Two Thai teachers of hill tribe, rural and urban students, a Chuukese instructor, and three Taiwan colleagues developed curriculum to engage indigenous, underrepresented, rural and mainstream/urban primary through post-secondary students in collaborative, culturally responsive, inquiry and community-based learning. Field notes, photos and videotapes, student work, and researcher journals indicate outcomes of positive student learning, affect, and school-community partnerships. Instructors recognized the importance of including local issues and indigenous knowledge in the curriculum. The study suggests place-based science learning addresses principles of UDL in increasing ways for learners to access information, to demonstrate learning, and to engage their interests and prior knowledge, but is more likely to be issues oriented and inclusive of indigenous, local and critical perspectives.

Purpose

This multi-site, international, cross-cultural study explores two related questions: Does place-based science instruction provide access to learning for culturally, linguistically, economically, and physically, and cognitively diverse students? If so, might place-based science instruction meet key criteria of universal design for learning (UDL)? How are these approaches to broadening access to science learning similar and different? Findings are discussed in the context
of science as a form of knowledge commons and science education as enabling learners to become literate, i.e., able to understand and participate in transdisciplinary science discourse communities that characterize a rapidly changing, globally connected world.

**Introduction**

*Science Education in 21st Century Contexts*

At then end of the 19th Century, John Dewey (1897) viewed the world as changing so rapidly he urged educators to ground learning in the dynamics of students’ lives and communities. At the start of the 21st Century, educators and policy makers continue the call to close the gap between school learning and students’ lives. The Partnership for 21st Century Skills, National Science Teachers Association, and National Council for Geographic Education recently proposed a set of 21st century skills (www.21stcenturyskills.org/) that align school knowledge and skills with the integrative, process-oriented knowledge and skills reflective of a rapidly changing, complex, globally interconnected world. These include critical and systems thinking, problem solving, creativity and intellectual curiosity; collaboration and self-direction; global awareness and civic literacy.

This transdisciplinary and transformative vision expects all students to be engaged, creative learners able to evaluate and effect changes in their lives and communities. It asks teachers to apply student-centered instructional approaches that address individual, cultural, and geographical diversity. Teachers’ roles shift from that of curriculum deliverers to curriculum developers able to connect students’ diverse experiences to meaningful, active learning about real world issues that, like the spread of infectious diseases or climate change, have both local and global impacts.

Education as authentic engagement versus transmission of information requires teachers themselves to be knowledgeable about, engaged in, and able to introduce and connect students to academically and socially valued discourse communities characterized by certain ways of communicating,
behaving, and thinking (http://en.wikipedia.org/wiki/Discourse_community). Fairclough (2006) holds that “people need resources to examine their placing…between the global and the local…and need from education a range of resources for living within socially and culturally diverse societies” (p. 151).

Universal design and place-based learning are two approaches to teaching with different histories but the same goal of enabling all students to be successful learners. The sections below introduce the curricular approaches of universal design and place-based learning as shaped by different histories and influenced by different ideological perspectives.

**Literature Review**

*Universal Design for Learning*

Universal design (UD) was first applied by architects and urban planners in physical contexts to expand the range of users who could move freely and access facilities (http://en.wikipedia.org/wiki/Universal_design). Familiar modifications include curb cuts and building ramps, handicap accessible bathrooms, Braille on elevator controls, and audible and visual street crossings. In the latter part of the 20th Century special education and disability advocates extended the concept of UD to assistive technology to expand access to communication, information, and learning (http://en.wikipedia.org/wiki/Assistive_technology). Developments in media, communication, and computer technology provided new tools to support learning of students with physical, cognitive, and emotional disabilities.

Primary through post-secondary educators are now exploring ways to apply UD to reduce barriers to learning for all students. In the way that UD in assistive technology means that televisions now all provide captions as an alternate mode of communicating information, UD in education applies curriculum design that addresses needs of diverse learners from the outset, eliminating the need to modify curriculum designed for mainstream, general education students.
The Center for Applied Special Technology (CAST) defines Universal Design for Learning (UDL) as “a framework for designing curricula that enable all individuals to gain knowledge, skills, and enthusiasm for learning” (http://www.cast.org/). UDL is based on brain-based research that suggests learning occurs through recognition, strategic, and affective neural networks. This leads to three design principles (http://www.cast.org/teachingeverystudent/ideas/tes/chapter4_3.cfm):

1. To support recognition learning, provide multiple, flexible methods of presentation
2. To support strategic learning, provide multiple, flexible methods of expression and apprenticeship.
3. To support affective learning, provide multiple, flexible options for engagement.

Curry (2006) applies UDL to science learning to guide the development of physical and social learning environments that address student diversity “including cultural, socioeconomic, ethnic background, gender, and ability levels” (http://www.alltech-tsi.org/articles/ud_science.php). Two scenarios of standards-based, inquiry-oriented lessons are presented, a place-based field trip to a local park and an object-based classroom lesson on Newton’s Laws using LEGO blocks. In these scenarios, teachers begin with familiar objects or places, use a range of media and computer-based technologies, and engage students in hands-on activities to support the learning of standards-based science.

UDL’s recognition of difference expressed in flexible, student-centered, constructivist strategies to engage students of different cultures, histories, and abilities implies that teachers are able to incorporate students’ prior knowledge and experiences as resources for learning. This assumes teachers recognize their role as, and are able to serve as cultural translators (Cheng, 1998) facilitating entry into school culture and disciplinary discourse communities. However, Chinn’s (2003) findings that preservice teachers’ personal experiences and cultural models of learning shape
their instructional vision underscores the importance of providing cross-cultural, experiential learning that enables teachers to reflect critically on their personal schemas of teaching and learning.

The curriculum ideologies Schiro (2008) calls scholar academic, emphasizing acquisition of disciplinary knowledge and social efficiency, emphasizing preparation to contribute to society are part of the history of Universal Design for Learning. In 2008 UDL was included in the Higher Education Opportunity Act (Public Law 110-315) as a “scientifically valid framework for guiding educational practice that… reduces barriers in instruction…and maintains high achievement expectations for all students, including students with disabilities and students who are limited in English proficient” (http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_public_laws&docid=f:publ315.110). The appeal to scientific validity and adoption by federal lawmakers positions UDL as a “scientific technique of curriculum making” (p. 51, Schiro, 2008) aligned with the ideology of social efficiency that believes “the purpose of schooling is to efficiently meet the needs of society by training youth in the skills and procedures they will need in the workplace and at home to live productive lives and perpetuate the functioning of society” (p. 4).

**Place-based learning: Science Education as access to a knowledge commons**

Place-based education began as a response to 19th Century reformers critique of schooling as unrelated to students’ lives. Dewey’s (1897) view of children as innately active and curious led him to criticize school science as decontextualized and disconnected from students’ lives. Dewey’s view of science education as providing learners with tools to understand their lives and participate in a changing world, also positions him as a founder of problem-based learning (Delisle, 1997). In recent decades, acute awareness of human impacts on local and global ecosystems (Holdren, 2008),
recognition that cultures differ in their views of the natural world, (Ogawa, 1995; Cajete, 2000), and findings of declining student interest in science and technology (Organisation for Economic Cooperation and Development, 2006) has spurred interest in the potential of place, inquiry, and culturally responsive science to engage diverse learners.

As conventionally taught, science students learn that scientific facts and universal laws are discovered through a scientific method characterized by impersonal, culture-free objectivity. In reality, studies show that scientists explicitly address local contexts and employ a wide range of tools, practices, and communication strategies in constructing scientific knowledge (Latour & Woolgar, 1979). Communicating scientific knowledge to diverse publics, e.g. students and community members, is an even more complex process due to the need to address a range of different norms, expectations, and discourses. The contentious debates over climate change driven by the different interests, knowledge bases, cultures, and geographical locations of diverse groups suggests the complexity of engaging adult learners in a dynamic knowledge commons informed by science discourse. In this sense, science knowledge relevant to global learners is a knowledge commons, similar to a natural resource (water, air, wild fish stocks) shared by diverse groups (Hess & Ostrom, 2006). In the area of sustainability, Cash et al (2003) note that “scientific information is likely to be effective in influencing the evolution of social responses…to the extent that stakeholders perceive it to be not only credible, but also salient and legitimate (sic)” (p. 8086), i.e., sound, relevant, unbiased, and respectful of opposing views and interests.

If learning is viewed as a social response this analysis is relevant to the design of science curriculum addressing geographically, culturally, economically, and linguistically diverse learners. There is a growing body of research suggesting a place-based science approach leads to social responses valued in educational settings. The Place-based Education Evaluation Collaborative (PEEC) 2007 evaluation of programs in 12 states and 100 schools
(http://www.peecworks.org/PEEC/PEEC_Reports/) found student achievement improved, parent and community partnerships developed, teachers and students were engaged, and school culture tended to become more collaborative and supportive. Similar findings have been reported in evaluations of NSF funded programs in rural Alaska and Louisiana (Emekauwa, 2004 a, b) and USDOE programs oriented to Native Hawaiians (Chinn, 2006).

The historical connection between place and problem-based learning tends to support critical awareness of competing discourses. Orr (1994/2004) deplores the loss of knowledge of place, values, and practices that support sustainability and calls for education “measured against the standards of decency and survival” (p. 8) instead of economic competitiveness. The narrative of competition is learned in mainstream schools that rank students after a model that valorizes individual effort at the expense of personal relationships (Gee, 1997) and cultural and linguistic diversity (Chinn, 2007). In contrast, Hawaiian culture values cooperation, personal relationships, and reciprocity inclusive of plants, animals, and natural places (Gon, 2006; Abbott, 1992).

Cajete (2000) notes the potential for indigenous practices, values, and long term knowledge of place to inform Western science in participatory research oriented to sustainability. Kawagley and Barnhardt (1999) identify four indigenous views that could contribute to science knowledge and education by countering the discipline-based, short term perspectives of many Western scientific and educational endeavors. These views included: taking a “long-term perspective” to emphasize the cross-generational nature of education, recognizing that the “interconnectedness of all things” also applies to knowledge, valuing “adaptation to change” to emphasize the dynamic nature of education, and maintaining a “commitment to the commons” that recognizes “the whole is greater than the sum of its parts” (p. 134). The contrast between mainstream science learning shaped by scholar academic and social efficiency ideologies and indigenous science learning oriented to sustainability and systems thinking suggest the potential for science education to support critical
thinking about the ways different ideologies lead to different valuations and use of societal and natural resources.

*Characteristics of Place-based Programs*

Gruenewald (2008) thinks a place-based question, “What needs to be transformed, conserved, restored, or created in this place…[could] provide a local focus for socioecological inquiry and action that, because of interrelated cultural and ecological systems, is potentially global in reach (p. 149).” A human-in-ecosystem view recognizes interconnected social and natural systems as “complex adaptive systems where social and biophysical agents are interacting at multiple temporal and spatial scales” (Janssen & Ostrom, 2006, p. 1465). A view that explicitly recognizes the cross-scale, local-global, transdisciplinary, interconnected nature of science as a multicultural activity resides at the core of place-based science programs oriented to sustainability.

Woodhouse and Knapp’s (2001) review of place-based programs found they possessed 5 “essential characteristics” that established the unique, local nature of each program: 1) natural and historico-cultural content specific to place; 2) multidisciplinary approaches; 3) experiential and/or service learning; 4) broader focus than preparation for a technological and consumer-oriented society; and 5) understanding of place, self, and community as part of a social-ecological system. They concluded, “One of the most compelling reasons to adopt place-based education is to provide students with the knowledge and experiences needed to actively participate in the democratic process” (p. 33). Hall’s (2004) review of global adult environmental education programs found 7 characteristics: 1) a sense of place, 2) valuing of biodiversity, 3) connection with nature, 4) revitalization of traditional and indigenous knowledge and practices; 5) building of social networks; 6) understanding of power-knowledge relationships; and 7) valuing learning from elders. The critical roles of place and practice in transmission and revitalization of traditional and indigenous knowledge in Hawaiian culture is seen in Meyer’s (1998) findings from interviews with elders:
“Sites of practice, where the product, process and context were Hawaiian—\textit{that} (sic) was where both information and practice synergized and strengthened the threads of cultural continuity” (p. 143).

\textit{Ideologies of Place-based Learning and UDL}

Schiro (2008) views education in the U.S. as guided by 4 major Western ideologies that shape educational goals, actions and aims: \textit{scholar academic} focused on acquisition of knowledge shared by culturally literate adults; \textit{social efficiency} focused on efficient alignment of objectives, learning activities, and assessment; \textit{learner centered} focused on experience-based preparation for future life; and \textit{social reconstruction} focused on problem finding and problem solving in an imperfect world. From an ideological perspective, place-based curriculum design tends to be guided by some combination of learner-centered, social reconstruction, and non-Western, indigenous ideological frameworks. Additionally, where standards-based curriculum is mandated, the \textit{scholar academic} ideology is included in the design framework.

Characteristics of place-based programs suggest a situated, socio-cultural theory of learning in contrast to UDL’s brain-based theory incorporating sociocultural contexts in support of an individual’s affective, strategic, or recognition learning. Situated cognition theory (Lave & Wenger, 1991) holds that learning occurs through social interaction. Gee, Hull, and Lankshear (1996) write that “language, literacy, and learning can only be understood when situated in their social and cultural setting” (p.1). The study of self as part of place and community embeds individual learners in a place-based knowledge commons while an inquiry and problem-based orientation teaches active problem-solving for a common good.

Viewing learning as situated in sites of practice and engagement with diverse discourse groups provides a theoretical framework for teacher education integrating culture and science. The focus on students’ places encourages teachers to become familiar with local issues, contexts,
resources, and cultures. As teachers develop transdisciplinary local expertise and involve students in place-based learning, they establish local social networks that increase students’ access to learning. Transdisciplinarity supports exposure to multiple discourses originating from primary living and local as well as secondary historical sources. Curriculum design focuses on process as well as content, and learning is co-constructed among diverse members of a learning community with the potential to build new knowledge valued by recognized publics.

What is universal in this approach is the study of place as a *lifeplace* (Thayer, 2003), *bioregion* (Smith, 1999), or social-ecosystem shared by all members of the learning community. As teachers develop transdisciplinary knowledge relevant to local issues, resources, and cultural knowledge and involve students in place-based learning, the curriculum shifts from classroom learning from secondary sources to active learning from primary sources in the community.

**Place-based Professional Development and Teacher Agency**

Chinn’s (2006, 2007, in press) research in Hawai‘i finds that place and culture-based professional development has the potential to support teacher agency by exposing teachers to indigenous cultural roles and values. Up to the 20th Century, resource managers, *konohiki*, managed human behavior towards the goal of sustainability of each *ahupua‘a*. This historical role could be reoccupied by teachers guided by core indigenous values of *kuleana*, responsibility, and care for the land that feeds, *mālama i ka ‘āina*.

Maly (personal communication) notes “The natural cycles within the *ahupua‘a* (a resource unit or bioregion spanning sea to mountain top) were also the foundation of the Hawaiian family, social, political and religious structure, and it can be said that the Hawaiian culture itself is rooted in the land.” Place, culture, and problem-based professional development incorporating local, traditional, and indigenous knowledge and practices oriented to sustainability thus is potentially supportive of teacher agency. As Bandura (2006) notes, “humans can create visualized futures that
act on the present; construct, evaluate, and modify alternative course of action to secure valued outcomes…To be an agent is to influence intentionally one’s functioning and life circumstances” (p. 164).

Researcher Roles

For the past decade, the first author has taught a place-based, interdisciplinary science curriculum course primarily to in-service science teachers wanting to develop lessons their students will find engaging and meaningful. Initial assignments sensitize teachers to the concept of sense of place through historical research and interviews centered on the communities in which they teach. They explore their communities for resources relevant to their instruction then incorporate these sociocultural and geographical contexts in writing culturally responsive, standards and place-based lessons that dissolve boundaries between science learning and students’ lives, cultures, and environments (Chinn, 2007). Thai and Chuukese case studies were conducted by graduate students employing an explicitly place, inquiry, and culture-based framework learned in the first author’s classes. The Taiwan case study is reported by science education colleagues in Taiwan who employed a participatory curriculum development framework. The first author carried out site visits with teacher-researchers in Thailand and Taiwan.

Findings from studies of place-based science education in Thailand, Chuuk, and Taiwan allow exploration of the similarities and differences between place-based science education and Universal Design for Learning. Results from the cases are analyzed according to three principles of UDL that are associated with increased access to learning: multiple representations of information, diverse modes of expression and action, and multiple ways to engage students’ interest and motivation.

Instructors, Settings, and Populations
Thailand: In Bangkok and two rural schools in rice-growing communities, teacher researchers Rojjana and Thip implemented inquiry, problem and place-based science lessons centering on water quality, ecology of rice fields, and endemic mosquito-borne diseases. As teachers, they are interested in place-based learning in response to the Ministry of Education’s directive for schools to provide learning relevant to their communities while meeting national curriculum objectives. Rojjana’s private, selective Bangkok school serves students from urban, middle class, educated families. Her rural government school in Lampang, northeast Thailand, serves 100 predominantly hill tribe students, a number of whom were orphaned due to political unrest in regions bordering Laos and Burma. Barriers to teaching and learning include limited science resources, diverse cultures and home languages, resulting in low scores on national exams. Unpaved roads lead up to Thip’s rural high school east of Bangkok near the Mekong River/Laotian border. Students from 6 rice-growing villages score in the lowest decile in the province.

Chuuk: Margarita Cholymay, a Chuukese college instructor teaches English to remedial college students in a Chuuk community college. She grew up in a small, rural community in a family guided by traditional knowledge. Her study was intended to support integrated language arts in the context of intergenerational transmission of knowledge relevant to breadfruit, the staple crop in traditional Chuukese culture. Chuuk as a member of the Federated States of Micronesia, allows open emigration to the U.S. Roughly 50% of Chuukese emigrate for economic opportunities, but in Hawaii, though English is the language used in Chuuk’s schools, teachers find many Chuukese students lack the linguistic, cultural, and academic skills and knowledge that support transition into school.

Taiwan: Professors Yen, Hou, and Lee, Han Chinese science educators worked with tribal elders and Han teachers to develop and co-teach place-based lessons integrating science and culturally important plants, musical instruments, and activities. Taiwan’s majority, mainstream Han
Chinese students almost universally complete the compulsory 9 year schooling and move into high schools. In contrast, aboriginal students who differ culturally and linguistically and tend to live in the mountainous interior, drop out at a higher rate from junior high school, and of the completers, less than 50% enter high school (Guo, 2008). Site visits in summer 2009 to several tribal communities showed interest in future place and culture-based science programs.

**Methodology**

This qualitative case study spans three years and utilizes a range of methods: field notes of site visits in Thailand and Taiwan; participant-observation of instruction in Thailand; meetings with Thai teacher-researchers at all stages of planning and research; meetings with administrators and community members in Taiwan and Thailand; and video and photo documentation by all participants. Document analysis include unpublished research reports, teachers’ written lesson plans, research proposals, Human Subject Applications, student documents, and e-mails.

**Results**

*Thailand: Place-base curriculum in rural and urban elementary schools*

In summer 2008 Rojjana worked with teachers at a small rural school in Lampang serving hill tribe children speaking 7 languages. Teachers who employed teacher-centered instructional strategies were introduced to student-centered pedagogical strategies and inquiry, place, and hands-on science learning. The curriculum interventions centered on issues relevant to the community: rice field ecology, water quality, and control of dengue and malarial mosquitoes. Field notes record enthusiastic and vocal students in classroom and community sites where children spoke to rice planters, studied plants and animals in the community, learned about the village’s water supply, and prepared dengue flyers and posters for community education. At their first ever school-community science exposition, students displayed projects on water tests, use of flowers to replace artificial food colorings, use of natural products to replace plastics, and the science of batteries and other
familiar items. Students learned composting, cleaned the campus of plastic litter (potential mosquito breeding sites), and planted a school garden with parent help. Survey results show the shift from passive, classroom-based to active, inquiry and place-based learning was viewed positively by students and teachers.

In summer 2009, Rojjana co-taught an optional science class with elementary colleagues in a selective, private Bangkok school. She piloted the previous summer’s place and inquiry-based mosquito ecology curriculum in an urban school serving economically advantaged students. Topics included life cycle, identification, biological controls, ecology, and diseases such as dengue, malaria, and filariasis. Questions generated by the 5th graders’ became themes for team research, including interviewing researchers and doctors (often their parents and relatives). The curriculum unit culminated with school and community outreach. Student evaluations revealed they considered the assignments hard and time-consuming, but the fact that enrollment increased from 15 to 30 (when the class closed) indicated high levels of student interest were communicated to peers who chose to enter the class.

Observations of Rojjana’s student-centered, place, culture, inquiry-oriented instructional strategies by teachers, administrators, and representatives from the Ministry of Education over the past 2 years have led to requests for her to expand her teacher education program to more schools. Interest is especially high in expanding the program, though still in pilot stage, to schools serving rural, linguistically diverse communities.

Ihailand: Place-based curriculum in a rural high school

In summer 2009 Thip and several high school colleagues co-taught three curriculum units that she had designed to increase active, inquiry, and social learning; diversify instructional and assessment strategies; and connect science content to students’ lives and places: dengue mosquito ecology, water quality, and forest ecology/ethnobotany. Students from rice farming families in 6
villages travel over unpaved roads to her high school in a small village east of Bangkok near the Mekong River which serves as the border with Laos. A 2-day site visit showed groups of 12th grade biology students rotating through learning centers (innovation #1) at different tables to study mosquito life cycle, biological controls, egg traps, mosquito anatomy, and why mosquitoes do not transmit AIDS. The next day, groups reinforced learning by arranging key words into sentences and creating and presenting posters (innovation #2). Students then went into the village (innovation #3) to collect larvae to raise and identify, skills they will extend to their own villages to map mosquito breeding sites and interview relatives (innovation #4) about their experiences with dengue. Reflections were collected from 58 12th graders, 13 males and 45 females responding to open-ended questions on questionnaires and evaluations at the end of each lesson. Responses were compiled, analyzed, then divided into 2 broad categories: 1) engagement in learning and 2) connection of science learning to their daily lives.

**Engagement in learning**

In this category, a careful reading of students’ reflections revealed 3 sub-themes: engagement, social learning and critical thinking. The following quotes are from Thip’s research report (Personal communication).

First, I asked students about which learning activities are most enjoyed in the biology class. About 51% of students mentioned that they enjoyed science activities outside classrooms. Specifically, learning in the real environment was challenging, interesting and exciting to them. In addition, one of them said, “doing experiments and investigation helps him/her more clearly understand science content than by reading books.”

Second, students benefited from social learning. They felt comfortable working in groups, sharing their ideas, and establishing harmony though it increasing their responsibility to accomplish tasks. One student said, “To work in a group was an opportunity to gain a new
friend.” After working together the student realized that the person s/he had disliked intensely was not bad as a friend. Another one said, “Discussions involving the whole class are a new learning experience.” S/he had learned how to express ideas, listen and respect other’s ideas in the class.

Finally, using place-based learning promotes critical thinking in my students. One of the students said “Learning by doing allows him/her to explore, analyze and learn new things.” In addition, another student said “learning through this method enhances understanding of scientists’ work and also trains a learner to be a scientist in the future.” Another student thought activities supported his/her learning about how to analyze something from different points of view.

Connecting science learning to daily life

Students were asked if they thought studying biology was relevant to their everyday life or communities. Nearly 60 % students stated that they used mosquito knowledge that they had learned from the class in their daily lives. Seventy percent of them agreed that to protect people health from mosquito diseases in their communities they need to work together to destroy mosquito breeding places and to protect themselves and their family members from mosquito bites by using nets while sleeping and cleaning and arranging houses with light and airy spaces.

These positive results encourage Thip to continue developing new place and inquiry-based curricular units with school and community colleagues. She views herself as a scientist-teacher seeking to build both content knowledge and instructional skills. She finds her rural setting rich in human resources and ideas for lessons that will serve her community. Though she will complete her graduate degree this summer, she says she is “greedy” to learn more and hopes to share her
field-tested curricula and pedagogical approaches with science and public health educators in her district and country.

*Chuuk: Place-based curriculum in a remedial college class*

Margarita Cholymay’s 18 remedial English students, 9 males and 9 females, came from both coral atolls and high volcanic islands. The majority failing the college entrance test are graduates of English language public schools that follow U.S. models. Growing up on different islands in Chuuk contributes to differences in cultural knowledge and English fluency. Students from outer islands continue traditional cultural practices, but opportunities to learn English outside of school are limited by access to books, radios, TV, and video players. Students living in population centers around the central lagoon or on high volcanic islands have access to technology, but have shifted away from traditional practices supporting a sustainable lifestyle. The culturally responsive, place-based lesson had a dual intent: to develop students’ mastery of English through student-centered inquiry into traditional knowledge that was being lost as traditional foods, customs, and values were displaced by outside influences.

Students interviewed elders and family members to learn local names of breadfruit, their characteristics, and propagation. Students compiled findings and presented them to the Agricultural Department. Students were able to identify about 23 different types of breadfruit in Chuuk, some new to agricultural department members. From the different types of breadfruit and traditional knowledge gathered from parents and elders, the students learned how Chuukese classify breadfruit by shape, best season to plant and harvest, seed/seedless varieties, characteristic leaf shapes, different ways of preparation, preservation in underground storage sites, and places where each can best be grown.

Mrs. Cholymay identified several implications from her study. First, students came to realize they improved their ability to use the English language through researching, sharing,
observing, speaking, reading and writing. Second, they learned important cultural lessons from family members. Third, they learned that if they continued caring for and planting breadfruit trees, they would have a local source of food, reducing reliance on imported rice that many cannot afford. Finally, they learned that breadfruit is more nutritious than rice. As a teacher educator, she concluded that culture and place-based curriculum development could be included in teacher training. Rather than limiting the teaching to existing curriculum and course outlines, teachers could be creative in integrating those aspects of students’ traditional knowledge that are important and relevant in current situations.

Taiwan: Participatory Construction of Indigenous Science Instructional Module

For 3 years, Yen, Hou, and Lee worked with indigenous elders from 5 tribes and Han teachers at 4 schools to develop and co-teach place-based lessons integrating science with indigenous cultural knowledge and practices. Curriculum was co-developed in the areas of culturally important plants, indigenous musical instruments and ways of telling time and marking seasons. Following the lessons, student interviews and journal entries indicate much of this was new, engaging, informative, and supportive of their indigenous cultural identity. When asked by teachers what they thought about co-teaching by elders and teachers, students responded positively:

Student 1: To have both of them in class is better. The elder knows more while the teachers are better at explaining.

Student 2: Both of them teaching us is better; the elder leaves a deep impression and the teacher can learn, too!

Co-instruction of indigenous and school-based science lessons by elders and classroom teachers helped students recognize the science in indigenous knowledge, e.g., the periodic appearance of different animals and plants and the 12 traditional festivals as an indigenous form of time-keeping. Participating teachers recognized their responsibility to support transmission of
traditional knowledge. The researchers found that methods used by indigenous people to pass on knowledge differ from classroom instruction in being context-rich observing and doing versus listening and reading. Knowledge gained spanned arts and craft techniques, cultural practices and values, and understanding of the relationships between people and nature. Yen et al conclude:

Earth, mountains, forests, oceans and tribes serve as the major learning locations for indigenous students. The process of learning is obtained throughout daily life where one encounters problems. By conceiving solutions to these problems, an individual is educated. Reflecting on their own learning and positionality as Han “colonists” they wrote, “Realizing that we are ‘learners’ rather than ‘researchers’ should be the first step to take when working in this field.”

Site visits to several tribal centers in summer 2009 by Yen, Hou, Lee, and Chinn showed strong desires by tribal leaders to maintain traditional ways and support for educational collaborations with Taiwan colleagues. Barriers to culture-science integration include lack of indigenous cultural knowledge among Han teachers, loss of cultural knowledge and language, and an emphasis on school-based tests as gate-keepers to students’ educational futures.

Discussion

UDL’s goal to increase each individual student’s access to information and learning emphasizing use of educational technologies positions culture, place, and polyvocality as possible but not essential elements of curriculum design. Place-based design also addresses universal access to learning as every student has the potential to engage and contribute his/her experiences in the shared place to a growing body of new knowledge. However, place-based learning’s inclusion of culture, place, and problem-solving in curriculum design has the potential for transformative change in educational practice. The site of learning expands from classroom to include the community, shifts from teacher-directed to student centered, and expands the sources of learning from school-based teachers and textbooks to diverse community-based resources.
These shifts are noted in each of the studies, whether in Chuuk, Thailand, or Taiwan. The results of the cross-case study show place-based science teaching expanded access to learning of students across cultures, languages, and ages of students. UDL’s three principles of multiple representations of information, modes of expression and action, and ways to engage students’ interest and motivation were met in the following ways.

1. *Multiple representations of information:* Chuukese, Thai, and Taiwanese students accessed information via lectures from teachers, demonstrations by elders, a variety of texts including textbooks, web sites, short videos, classroom and community activities, peer talk and presentations, interviews with community members, and hands-on inquiry activities in school, community, and home environments. Information was represented in multiple languages, indigenous as well as the dominant language of the country and in a variety of disciplinary forms, including language arts, science, social studies, and mathematics.

2. *Modes of expression and action:* Students employed multiple modes of expression and action through individual, small group and whole class oral communication in multiple settings; employed writing, drawing, diagramming as textual modes of communicating; engaged in exploring, inquiring, learning about and applying a range of tools and skills across disciplines; and employed discourses associated with home, cultural practices, community activities, and academic disciplines.

3. *Ways to engage students’ interest and motivation:* Teachers and students learned about themselves, each other, their community, and developed new resources for teaching and learning outside the classroom. The graduate students and researchers who designed and field-tested place-based curriculum evaluate it as increasing students’ interest and motivation through contextualized, personally relevant content, and authentic, peer and cross-generational communication. Authentic culturally meaningful place-based science
activities helped them to think critically about their social-ecological systems and how to act within them.

Implications for Teacher Education

These findings suggest place-based science instruction does meet the criteria of UDL but goes beyond UDL’s focus on access to academic learning in a number of important dimensions. Students, teachers, and researchers’ reflections on their learning suggest that place-based learning’s historico-cultural, human-in-ecosystem, and problem-based orientation is more likely to support critical thinking, civic engagement, and individual/group agency. Finally, participants recognized that science knowledge is both constructed and evaluated differently by different groups in society and that powerful groups have an interest in what is considered valuable science knowledge.

This meta-level awareness of the power-knowledge dimensions of science suggests the potential for place-based learning to go beyond UDL approach towards Dewey’s vision of active learning situated in students’ lives. This knowledge, gained through participating in diverse discourse communities supports understanding the present, how it is shaped by the past, and how local decisions and actions have global implications that affect the future.

Conclusion

Curriculum designed to address Universal Design for Learning or place-based learning both hold the potential to increase students’ access to learning. Whether one approach is favored in science teacher education and in the classroom may be due to educational ideologies that undergird visions of education. Though both address culturally, linguistically, and ethnically diverse learners, the results of this cross-case, cross-cultural study suggest place-based curriculum design incorporates complexity, real-world inquiry, and critical discourse as hallmarks of a living curriculum. This view suggests that place-based teacher education prepares teachers to function as local experts, engaging diverse learners in multiple discourses that support understanding of science
as a dynamic, multicultural knowledge commons with a variety of tools and methods to inform responsible action in a shared world. These tentative conclusions should be explored in cross-case research involving curriculum designed according to UDL as well as place-based design frameworks.

References


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