Incorporating Cultural Models into Community-based Professional Development:
Impact on Teachers’ Practices, Knowledge, and Professional Networks

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Abstract

The hypothesis that conflicting cultural models of learning may contribute to the marginalization of Native Hawaiian students, particularly in science guided the design of 2 professional development classes designed to enable teachers to write and teach lessons integrating Indigenous Hawaiian and western science education knowledge and practices. Professional development co-taught by cultural translators with expertise in indigenous science and/or western science was modeled on the makahiki na o Lono, the annual island-wide circuit that gathered information across each ahupua‘a (sustainable socioecological unit) and role of konohiki, resource managers who monitored and maintained sustainable practices within each ahupua‘a. After 9 months, teachers developed new instructional repertoires, understood how indigenous science and western science could be connected in instruction, identified three times more human and place-based resources, and found that grounding science lessons in familiar place and cultural experiences highly engaged their predominantly Native Hawaiian students. Results suggest enabling teachers to experience how cultural models shape learning empowers them to integrate formal, non-formal and informal knowledge to improve student learning and validate non-dominant cultures.
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Introduction

What underlying factors contribute to the 10% gap in reading and mathematics scores of Native Hawaiian students in Hawaii’s public schools (Hawaii Department of Education, 2010) and underrepresentation in science and science education at the University of Hawai‘i at Mānoa (Chinn, Businger, McCoy, Nogelmeier, Rowland, 2010)? This study examines the systematic displacement of Indigenous cultural knowledge, language, values, and practices associated with American colonization from the theoretical perspective of cultural mental models (Craik, 1943; Nisbett & Norenzayan, 2002; Bang, Medin, Adtran, 2007). Hypothesizing that conflicting, dominant and subordinate cultural models of learning may contribute to the marginalization of Native Hawaiian students, particularly in science, the study explores the outcomes of a professional development program that explicitly provides Native Hawaiian cultural models and culture and community-based resources for science teaching and learning.

The study involved 18 PreK-12 science teachers enrolled in EDCS 433 Interdisciplinary Science Curriculum and/or EDCS 450 Science Materials and Methods,  Mālama  I Ka 'Āina, Sustainability co-taught by cultural translators with expertise in Indigenous Hawaiian and/or mainstream western science knowledge, practices, and language. The goal of the community of practice (Wenger, 2006) was to connect school learning to community and culture-based “funds of knowledge” (p. 134, Moll, Amanti, Neff, & Gonzalez, 2001) over the 9-month professional development program.

Research Questions
The research addresses 4 questions related to professional development in out-of-school settings, including museums and culture-based organizations, e.g., Polynesian Voyaging Society: 1) How do teachers’ instructional repertoires change? 2) How do teachers assess changes in their knowledge? 3) How do teachers informal and formal professional networks changed? 4) How does professional development in out-of-school, authentic settings affect teachers’ ability to engage underrepresented Native Hawaiian students and other culturally diverse students in science?

**Literature Review**

*Theoretical Framework*

Research is guided by sociocultural learning theory in the contexts of Native Hawaiian science and mainstream western science/science education. If marginalization in science is examined through the theoretical lens of culturally shaped mental models (Bang, Medin, Adtran, 2007) then the underrepresentation of Native Hawaiians and Native Americans in science majors may be viewed from the perspective of conflicting cultural models of unequal power in mainstream educational institutions. Culture is defined in Webster's II New Riverside University Dictionary as: "The totality of socially transmitted behavior patterns, arts, beliefs, institutions, and all other products of human work and thought typical of a population or community at a given time."

If mainstream science education is considered a subculture of Western science, reflecting the behaviors, beliefs and institutions of anthropocentric Western culture and Indigenous Hawaiian science reflects ecocentric Hawaiian cultural behaviors, beliefs, and institutions, then providing teachers with model science lessons where these cultural systems overlap and provide complementary understandings should lead to changes in teachers’ instructional repertoires and knowledge leading to incorporation of indigenous Hawaiian and western science perspectives. This
explicitly critical multiscience (Harding & Figueroa, 2003) approach relies upon the ability of
cultural translators, experts in Hawaiian culture and/or in western science to develop a discursive
space in which educators develop a transdisciplinary knowledge base that supports their
development of transdisciplinary instruction relevant to their own students and communities (Chinn,
2008).

Professional development occurred in a series of communities of practice (Lave & Wenger,
1991) composed of cultural practitioners, scientists, and science educators engaged in issues-
oriented, community-based activities e.g., ecological monitoring and biorestitution (Chinn, 2008).
The notion of culturally shaped mental models (Craik, 1943; Maly, 2001; Nisbett & Norenzayan,
2002; Bang, Medin, Adtran, 2007) guided the design of professional development modeled on the
traditional Hawaiian makahiki na o Lono, the annual island-wide circuit that gathered information
across each ahupua‘a (sustainable socioecological unit) and role of konohiki, resource managers
who monitored and maintained sustainable practices within each ahupua‘a (Abbott, 1992). The
following paragraphs present an overview of an ecocentric Indigenous Hawaiian cultural mental
model. (There is an extensive literature on anthropocentric, western models of science and science
education that will be only touched on below.)

Isabella Aiona Kauakea Abbott, first Native Hawaiian woman to earn a natural science PhD,
explains the significance of the makahiki na o Lono as a religious occasion welcoming the return of
Lono (god of planting) as the bringer of rain and winds. Beginning the first new moon after the
Makali‘i [Pleiades] was seen, conflict was forbidden as mo‘i, the highest ranking chief embodying
Lono, the god most important to survival, visited each ahupua‘a, (largely self-sustaining geographic
units), receiving ceremonial gifts, ho'okupu (meaning to grow) and acquiring information about
each ahupua‘a. The mo‘i’s duty was to mālama ʻāina, care for the resources of land and sea that
sustained all (ibid; Handy, Handy, & Pukui, 1991). Dr. Abbott connects the makahiki’s elaborate rituals to ecological ethics: "the belief that maintaining a right relationship with the gods and the earth is humanity's basic spiritual challenge...Makahiki's biological significance: a two-month period when the land could rest, plants could grow without being harvested, and the ocean could replenish itself" (p. 22).

Maly (2001) notes that:

Hawaiian customs and practices demonstrate the belief that all portions of the land and environment are related, like members of an extended family...Just as place names tell us that areas are of cultural importance, the occurrence of a Hawaiian nomenclature for environmental zones also tells us that there was an intimate relationship between Hawaiians and their environment.

Viewing the environment as co-extensive with human family suggests that Native Hawaiians developed what in the west is called "ecological justice" a notion of fairness and moral considerations based on shared environments with plants, animals, communities, and natural systems (Alrøe, Byrne, & Glover, 2006). Huihui Kanahele-Mossman (personal communication), a science educator from a family of Hawaiian cultural practitioners notes that "wahi a na kupuna (as said by elders), according to the kumulipo (Hawaiian origin myth) and several makahiki referenced oli in Malo, each kalo (taro), each 'uala (sweet potato), each la'i (ti leaf), much like we do, has a genealogy. For this reason (again said by kupuna) the mea kanu (crops), or even la'a'u (tree, thicket) , manu (bird), honu (turtle), limu (underwater plants), and kanaka (person) are spoken of at the same level of existence.

This ethical, systems-oriented, ecocentric perspective is consistent with the State Motto, the Hawaiian proverb "Ua mau ke ea o ka ʻāina i ka pono. The life of the land is preserved in
righteousness” (Pukui, 1983: 2829). Mauka-makai interdependence within ahupua’a supported “an organized conception of form…where from lower forms of life emerge offspring on a higher scale and water forms of life are paired with land forms” (p. 3, Beckwith, 1940/1970). Ahupua’a supported a socio-ecological monitoring system that combined long-term, place-based environmental and cultural knowledge into real-time management oriented to sustainability. Konohiki, lower ranking chiefs who managed resources within each ahupua’a mobilized people to maintain fishponds and auwai that distributed water, and proclaimed open (noa) and closed (kapu) harvests of plants and animals. The saying “Hahai no ka ua ka ululā'au; Rains always follow the forest” (Pukui, 1983: 405) suggests Hawaiians knew forests protected the watershed thus cut trees only as needed.

**Methodology**

This action research studies the outcomes of science professional development applying the cultural model of ahupua’a, the Native Hawaiian geographical unit, the processes of the makahiki as a gathering of knowledge across multiple sites, and the role of konohiki as a resource manager. The author served as lead instructor of the team-taught courses. She was experienced in culturally responsive science instruction as a former high school instructor of Plants and Animals of Hawai‘i and as an instructor of place and culture-based teacher education courses. Over the course of 9 months, teachers experienced a version of the makahiki on Hawai‘i and O'ahu. After an orientation on O'ahu, teachers visited sites from coast to mountains on Hawai‘i for 5 days in June 2011 to learn from more expert project teachers and resource managers, most Native Hawaiian, all modeling a multiscience approach to monitoring and restoring local ecosystems. At a mountain site, teachers and hosts (including Stanford's Peter Vitousek and a Hawaiian paniolo, cowboy) exchanged cultural protocols, discussed reasons for western science interest in recovering indigenous science
knowledge, and engaged in service learning associated with research on indigenous Hawaiian dry
land sweet potato cultivation.

Teachers researched and shared the cultural, historical, and ecological changes in the
*ahupua'a* in which they teach to develop resources for writing and teaching place-based science
lessons oriented to active science literacy and sustainable social ecosystems. Classes met in June
and October 2011 at a variety of school and community sites on O'ahu to continue developing
culture-science knowledge and practices in authentic places. Over the course of 9 months, learning
activities that were evaluated by teachers included:

- Water testing
- Cycles: water, nitrogen, energy
- Aquaculture, hydroponics, gardens
- Polynesian voyaging, PVS experiences
- pH, acids, base
- Canoe Plants
- DNA from strawberries
- Overnight immersions

Other

- Place-based geology
- Origins of Polynesians
- Sustainability: Hawaiian views
- Science in 'ōlelo no 'eau, mo 'ōlelo, place names
- Native, endangered, invasive species
- 5E lesson planning, curriculum mapping
- Interacting with a variety of experts
- Field trips to school and community sites
- Interacting with peers and Kūlia Team

The final whole class meetings March 9-10, 2012 were held at a community site in
Nānākuli, a predominantly Native Hawaiian community and the University of Hawai‘i at Mānoa in
urban Honolulu to share lessons and evaluations of student learning and engagement.

*Data sources and methods*

Teachers’ writings, field notes, and photographs and videotapes are primary sources of data.
Documents include teachers’ written evaluations of professional development activities, lesson
plans, instructional activities, reflective writings, comments on peer writings, and e-mails over the
course of the 2011-2012 school year. Field notes, researcher journals, photographs, and videotapes
provide data on professional development activities, instructor reflections, and participants’
instructional activities. This study presents preliminary results based upon field notes, participant observation throughout the program, and written evaluations from 14 teachers.

**Results**

Written evaluations and teachers' lessons, both presented and submitted as lesson plans strongly suggest that professional development (PD) providing Hawaiian models of resource managers supports culturally responsive, place-based science teaching. Results from written evaluations following the final class meetings March 9-10, 2012 are reported below.

After the June 2011 5-day cultural immersion, the first major PD activity, Mahealani, a Native Hawaiian preschool teacher who teaches Native Hawaiian children wrote: “I need to find out what my *kuleana* (responsibility) is….how am I gonna make a positive impact in my classroom and community. I would like to learn more about native plants that grow in Nānākuli/Wai‘anae because I lack that knowledge and I would like to try and grow those things in the *māla* (planting area)…planting natives gives me a positive feeling of contribution to the environment.” She named 3 community members who could be resources at the top of her paper. In March 2012, the same teacher reported that she now knew more than 21 people who could be resources and named Dr. Clyde Tamaru who had taught hydroponics in June 2011 as someone she would like to learn more from. The number of places she knew that could be resources for teaching increased from 3-5 to more than 21 places. Her narrative responses on the final evaluation are reported below.

The results of questions 1-4 assessing how participants' knowledge of people and places that they knew changed from June 2011 to March 2012 are presented in Table 1.

Table 1. Reported Changes in Resources for Science Instruction from June 2011 to March 2012 (n=14 Teachers)
<table>
<thead>
<tr>
<th># People</th>
<th>June 2011</th>
<th>March 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>n=3</td>
<td>0</td>
</tr>
<tr>
<td>3-5</td>
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<td>11-15</td>
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</tr>
<tr>
<td>16-20</td>
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<tr>
<td>21+</td>
<td>0</td>
<td>21+</td>
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<tr>
<td>Mean</td>
<td>6.5</td>
<td>Mean 18.7</td>
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</table>

<table>
<thead>
<tr>
<th># Places</th>
<th>June 2011</th>
<th>March 2012</th>
</tr>
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<tbody>
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<td>3-5</td>
<td>n=6</td>
<td>3-5</td>
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<tr>
<td>6-10</td>
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<tr>
<td>11-15</td>
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<tr>
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<td>21+</td>
</tr>
<tr>
<td>Mean</td>
<td>5.6</td>
<td>Mean 16.8</td>
</tr>
</tbody>
</table>

When asked which people and places they would like to visit again they included Polynesian Voyaging Society, Hōkūle'a crew, Clyde Tamaru--hydroponics/aquaponics sites, all the sites on Hawai'i Island, Bishop Museum, co-instructors and peers. Comments such as "Everyone of the kumu (teachers) students/classmates, or presenters had something good to share. I would like to visit Uncle Clyde again at Windward Community College" explain why the number of **people recognized as resources** shifted from a **mean of 6.5** in June 2011 to a **mean of 18.7** by March 2012 and the number of **places recognized as resources** increased from a **mean of 5.6** in June 2011 to a **mean of 16.8** by March 2012.

Teachers were asked to elaborate on any topic or aspect (listed above) of the past 9 months:

- Mahealani, Hawaiian Preschool Teacher: It is so hard to focus on one thing because the amount of knowledge and resources have been so abundant in the course. But the amount of literary resources (books on Hawaiian endemic and indigenous plants, invasive species, place names, ecosystems, fish) and science/lab equipment I received would have taken years to acquire and a lot of $.
• Hawaiian Preschool Teacher: Sustainability: Hawaiian views. I truly enjoyed and took pride on how my *kupuna* were able to be sustainable. All I leaned in this class goes back on how wise our *kupuna* were: voyaging, gardening, water quality, origins of Polynesians!

• Hawaiian 4th grade Teacher: I'd love to continue [exploring] the problem of water resources in our area--Wai'anae and the pollution or dumpsite that is projected to be in a Hawaiian community.

The following responses to questions 5-10 are quotes from evaluations of 2 preschool-K teachers, Mahealani and her colleague, and an elementary grade 1-5, middle school grade 5-8, and high school grade 9-12 teachers.

• Hawaiian language immersion 6th grade Teacher: When I first took this class, all the info was overwhelming. It was hard for me to connect science and culture. Now I can do it and it's a lot easier in all aspects of science. Lots of ideas from colleagues.

• Hawaiian 9-12th grade ag-science Teacher: DNA from strawberry. Fun and easy to do. Excellent for cell unit!

5. What is useful to you about learning science in the context of place and culture?

• Mahealani, Hawaiian Preschool Teacher: Place and culture-based science so much more meaningful for me and my *haumana* (students) especially since they are 3-5 years old they conceptualize things better when they can make concrete connections to what they know in their environment/place.

• Hawaiian Preschool Teacher: It allows me to take pride and ownership of my community. It allows me to be more knowledgeable and be able to pass it on to my students.

• Hawaiian 4th grade Teacher: It forces me to be more of an expert in our community.
• Hawaiian 7th grade Teacher: tools (water test kits), stipends, lesson plans/ideas from other teachers.

• Hawaiian 9-12th grade ag-science Teacher: Relevant and rigorous

6. What did your students think about learning science in the context of place and culture?

• Mahealani, Hawaiian Preschool Teacher: They loved being outdoors, planting our garden, observing birds, [learning about] Polynesian migration and introduced plants.

• Hawaiian Preschool Teacher: My students really appreciated and were able to connect with my science lesson plan. There were more engaged and also shared with their 'ohana (family) on what they learned in school. In fact one student was able to share that her older sister was also learning about wa’a (canoe) "just like me!"

• Hawaiian 4th grade Teacher: A high engagement with enormous energy and enthusiasm. They only wanted to do science research connected to all the content areas.

• Hawaiian 7th grade Teacher: Loved (sic) it! I wrote my Plan B on place-based curriculum. The data show the students learn more and are more engaged.

• Hawaiian 9-12th grade ag-science Teacher: "What--we are learning science--cool!"

7. One thing that would make the course better is....

• Mahealani, Hawaiian Preschool Teacher: I wish this was on-going...there's so much information to learn from Dr. Chinn, Kūlia team, other teachers and all the expert teachers.

• Hawaiian Preschool Teacher: to share in small groups our ideas of different lessons that we all could do with our students.

• Hawaiian 4th grade Teacher: more and more dialogue, immersion times together.

• Hawaiian 7th grade Teacher: More time to meet between the months of Dec-March.

• Hawaiian 9-12th grade ag-science Teacher: Have team leaders mentor a group of us.

8. I learned most about:
• Mahealani, Hawaiian Preschool Teacher: water testing, transecting, aquaponics, hydroponics.

• Hawaiian Preschool Teacher: wa’a and the ahupua’a--water quality and the different streams in my area (Nānākuli).

• Hawaiian 4th grade Teacher: Place-based and cultural research and practices in a scientific perspective. I learned how important the cultural component is to teaching students.

• Hawaiian 7th grade Teacher: How to relate science to culture/place; plants.

• Hawaiian 9-12th grade ag-science Teacher: hat other schools/teams are doing and how each lesson can be modified.

9. I would like to learn more about:

• Mahealani, Hawaiian Preschool Teacher: Simple science/place based lessons to use in the classroom.

• Hawaiian Preschool Teacher: how I could incorporate "science" with my wa’a lesson.

• Hawaiian 4th grade Teacher: more field studies with invasive species in our native forests, ocean, kula (land, fields), the physics and chemistry of things.

• Hawaiian 7th grade Teacher: Plants and ahupua’a; resources available to teachers for their students with regards to culture/place-based curriculum.

• Hawaiian 9-12th grade ag-science Teacher: Voyaging

10. I would/would not recommend this class to a colleague because...

• Mahealani, Hawaiian Preschool Teacher: Definitely recommend, mahalo, mahalo, mahalo, mahalo!

• Hawaiian Preschool Teacher: I was able to have more appreciation of my culture and how place-based learning is a lot more satisfying and engaging for students!
• Hawaiian 4th grade Teacher: It's everything a quality teacher needs--research, practice, lessons--rejuvenation.

• Hawaiian 7th grade Teacher: It changed my life and set my heart in a place that will hopefully allow me to help preserve the culture, people, and history. Mahalo nui loa for all you have given me!

• Hawaiian 9-12th grade ag-science Teacher: Everything you do and learn is relevant and connects students to "real world" learning.

Field Notes of Teacher Presentations

At the March 9-10 lesson presentations, pre-12 teachers reported their students enjoyed place and culture-based lessons. Middle school teachers said their students were more engaged and felt that they were acting a Hawaiian scientists--making hypotheses then studying water quality and animals in their own streams. Elementary students enjoyed learning Hawaiian stories, moʻolelo, associated with feature in their communities e.g., Maui slowing the sun so his mother could dry her kapa (bark cloth) then studying science phenomena embedded in the story.

Preschool teachers and children discussed whether the culturally important plant kukui (Aleurites moluccana) could have arrived in Hawaii naturally (wind, water, or wings) or with Polynesian voyagers. They discussed if wind could have blown them or birds could have carried the 4-cm. diameter nuts thousands of miles (no) or if they could have floated to Hawaii (maybe). They dropped and threw kukui nuts into a bucket of water then predicted if nuts that sank or floated would sprout. They planted several pots of floaters and sinkers and after 2 months only the sinking nuts had sprouted. The children concluded kukui trees had to be brought by Polynesian voyagers.

Implications for Professional Development

This study explored the following four questions:
1) How do teachers’ instructional repertoires change?

Lesson presentations and evaluations indicate teachers developed lessons they had never done before--identified and counted birds in their school grounds, took field trips to study water quality and stream animals within the culturally relevant context of taro pond fields, studied plant propagation in the context of plants brought by Polynesian voyagers--many are sterile, putting their energy into sugar, starch, and fiber--unable to become invasive. Teachers who experienced place and culture based inquiry and were provided with the tools to carry it out were more comfortable in translating it into inquiry lessons appropriate for their students.

2) How do teachers assess changes in their knowledge?

Through developing and teaching their own place and culture-based lessons, teachers targeted areas they would need to develop more expertise. (See responses to question 9.) Teachers not only assessed their knowledge but expressed their responsibility to become more knowledgeable local experts to teach and transmit culture, language, and science relevant to Native Hawaiian children and communities. They developed pride and ownership of their communities. This suggests that the cultural model of in-depth place-based (ahupua’a) knowledge and inquiry and place-based learning oriented to sustainability (role of konohiki) was understood by teachers as a way to teach western science and to contribute to their communities.

3) How do teachers informal and formal professional networks changed?

Responses to questions 1-2 on the final March 9-10 evaluation show that the number of human resources identified by teachers triples from a mean of 6.5 to 18.7 in the course of 9 months. They also show a tripling in mean numbers of places that can serve as resources from 5.6 to 16.8. This large increase and their comments show teachers recognized peers as well as outside experts as
professional sources. They especially valued peers with programs and places able to support learning. This suggests that teachers recognize, even prefer to learn from those with local expertise, reflecting the development of indigenous science knowledge about plants that yielded hundreds of varieties of major food plants selected for a variety of soil and microclimates (McClatchey, personal communication).

4) How does professional development in out-of-school settings affect teachers’ ability to engage underrepresented Native Hawaiian students and other culturally diverse students in science?

Teachers' responses to question 6 show they found their predominantly Native Hawaiian students were engaged and enjoyed learning science relevant to their lives, culture, and communities. Their own experiences and enjoyment of multi-science learning in out-of-school settings supported their development of parallel outdoors and out-of-school learning activities. Their findings that students enjoyed these experiences, worked well together, even wanted to connect all other content areas to science suggests teachers made strong connections between how they learned and how they structured students' learning.

It must be recognized that these professional development courses cost more per participant than more typical short term, classroom-based courses. Support from an award under the Native Hawaiian Education Act, US Department of Education enabled the provision of courses that spanned space and time and provided a range of human resources, experiential learning, and place and culture-based resources. However, teachers' lesson plans and gains in their knowledge of local resources reflect gains in place and culture-based pedagogical content knowledge in science (Chinn, 2012). Despite higher initial costs, these suggest investments in place and culture-based professional development will continue into the future. How teacher learning is reflected in student learning is an area to be explored further.
Conclusion

Professional development guided by the cultural models of ahupuaʻa as sustainable social ecosystems, the makahiki na o Lono as a process for gathering knowledge from authentic sites, and konohiki as local resource manager provided teachers with a multiscience, multicultural model for lessons relevant to their Native Hawaiian students’ cultures and communities. Teachers recognized the need to develop their own local expertise and identified areas for further learning, ideally supported by peers and experts met through the class. They recognized the important role of culture-science translators able to create the multiscience, transdisciplinary space where Hawaiian and western science complement each other. They expressed a growing understanding of the intersection of culture and science and developed a sense of their own place and responsibility for their culture and community.

Despite higher costs than typical short term, classroom-based professional development courses, building teacher learning in science upon indigenous cultural frameworks, places, and practices may empower all teachers, but especially those from marginalized groups who have few role models in STEM (science, technology, engineering, and mathematics) fields. Professional development that recognizes and connects formal and informal learning can improve access to education and validate the worth of individuals from non-dominant cultures (OECD, 2010).
References


