# Bilingual Latino Students Learn Science for Fun While Developing Language and Cognition: Biophilia at a La Clase Mágica Site

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## Abstract

In this article, the author suggests that children's natural inclination to explore nature, or biophilia, can be explored as a factor that encourages both cognitive engagement and language development. The author summarizes the types of scientific inquiries that bilingual elementary students and their university partners engaged in when guided to design their own projects at a predominantly Mexican-American school. Children inquiries took place at a *La Clase Mágica* site, an after school program in which university undergraduates, faculty, bilingual children, and the community come together with the purpose of learning and exploring technology through interdisciplinary methodologies. The findings indicate that children overwhelmingly chose living organisms and life-like processes as the focus of their inquiries. The author presents the work of an exemplary dyad to illustrate how children engaged in scientific inquiry while developing language and complex thinking.

## Keywords

La Clase Mágica, project-based learning, science, informal learning, language, after school program, partnership, parents, pre-service teachers, elementary students, university faculty

## Introduction

"*¿De veras no sabes nada de las mariquitas? Bueno el ciclo es la etapa de los huevos, después la etapa del larva, luego la etapa del pupa y finalmente el adulto...*" [You really don't know anything about ladybugs! Well, the cycle consists of phases including the egg, the larva, the pupa, and finally the adult...] explained Laura in a letter to *El Maga* making reference to the topic of her inquiry project at a *La Clase Mágica* (LCM) site. This excerpt illustrates part of the scientific vocabulary and the academic language that Laura acquired as she engaged in a self-selected project-based experience in an informal after school context. This study describes ways in which children's natural inclination towards nature, or biophilia, can potentially support cognitive growth and language development, especially if such

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endeavors take place in informal school settings such as those offered by LCM.

LCM is an after school technology club that started in California in 1983 as a place where bilingual children from a Mexicano community met with their *amigos* [friends] from the University of California, San Diego to play computer games (Vasquez, 2003). In San Antonio, Texas, LCM began operations in the fall of 2009 when the University of Texas at San Antonio (UTSA) obtained a grant from the US Department of Education with which to fund an after school program in which faculty and 20 undergraduate students or *aspirantes* (teacher candidates) would incorporate the use of mobile devices including smart phones, netbook mini-laptop computers, and tablets (Rodriguez, 2010).

UTSA faculty, *aspirantes*, and students from *Los Árboles* Elementary school met once a week and participated in informal activities. *El Maga*, a virtual teacher, monitored children's progress and held informal electronic conversations with them in the form of letters that generally ended with a question. LCM provided a space in which to freely explore content, language, and culture. Often, children used electronic devices such as iPads to access websites seamlessly, navigating content in English and Spanish. LCM's focus on learning and development centered "on enhancing cognition by building on the children's prior experiences and linking these to new information to create new understandings" in the language they choose to use (Vasquez, 2003, p. 49). In the spring of 2012, UTSA's LCM team decided to adopt a project-based inquiry approach to continue enhancing children's engagement in activities that promoted knowledge construction.

## Self-Selected Science Projects at LCM: A Pedagogy of Transformation that Capitalizes on Children's Biophilic Affiliation

Project-based learning is an inherently collaborative approach closely guided by the teacher. However, at the heart of a project-based critical approach to education is Freire's view of the teacher as an individual who also learns throughout the process. This transformation of roles is crucial in analyzing the overall experience at LCM and suggests that:

> ...through dialogue, the teacher-of the-student and the students-of the teacher cease to exist and a new term emerges: teacher-student with student-teachers. The teacher is no longer merely the –one-who-teaches, but one who is himself taught through dialogue with the students, who in turn while being taught also teach. They become jointly responsible for a process in which all grow. (Freire, 2003, p. 80)

This view of the learner as a decision maker is crucial to an after school club like LCM that seeks to open doors for authentic learning and student generated endeavors. The project-based approach is congruent with national science reform movements that promote substantial participation of children as decision-makers. For example, the Benchmarks for Science Literacy indicate that by the end of second grade students should "raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out" (American Association for the Advancement of Science, 1993, p. 285). An assumption underlying this study is that children are inherently inclined not only to explore the world in general, but are

specially attracted to life or life-like processes, a concept defined as biophilia.

Biophilia, Wilson (1993) proposes," is the innately emotional affiliation of human beings to other living organisms" (p. 31) and life-like processes. When given the opportunity, children tend to gravitate to and establish relationships with elements in nature that actively engage their senses. A tree trunk, for example, affords to be touched, climbed, hugged, etc. A rock, affords to be lifted, thrown, classified, etc. Affordances in nature, "are functionally significant properties in the environment which are defined by the relationship between the environment and an organism" (Chawla, 2007, p. 150). Gibson's (1979) concept of *affordances* is helpful in understanding the origins of children's emotional ties to elements in nature that basically *invite* or *beg* exploration. It is no surprise, Kellert (2002) asserted, that educators and publishers capitalize on this fascination by creating fiction and non-fiction stories overwhelmingly characterized by the presence of symbols from nature. Kellert (1993) hypothesized that one of the dimensions of biophilia is significantly symbolic and stated that a "limited indication of the symbolic function is reflected in the findings that animals constitute more than 90 percent of the characters employed in language acquisition and counting in children's preschool books" (p. 52). In contexts like LCM symbols of nature are now available in a variety of formats including iPad games, online versions of fiction and non-fiction books, and websites in English and Spanish that offer information on plants and animals.

## Context of the Study

The purpose of the study was to explore elementary students' scientific inquiries and their cognitive and linguistic engagement while involved in a self-selected project at an LCM site. The study took place during the spring 2012 semester. Adhering to a project-based approach, dyads of *aspirantes* and their elementary school *amiguitos* at *Los Árboles* Elementary investigated a topic. Prior to beginning their participation at the *Los Árboles* site, UTSA *aspirantes* attended a series of workshops aimed at providing background on LCM's guiding principles, addressed issues of technology, and shared details of a 10 week agenda during which UTSA undergraduates were asked to collaborate in pairs with a *Los Árboles amiguito*. Emphasis was placed on principles that have guided LCM since its inception including:

1. The activity must be a mixture of play and education. The play element is needed for the children to participate; the education element is needed for the adults to justify support.
2. The mix of play with education must be such that children come voluntarily.
3. Learning is an active process that is fostered by norms of intergenerational interaction in which adults work alongside children as co-participants and not as directors.
4. Each site combines community institutions with university courses.
5. There is an emphasis on interactive technologies, including but not limited to computers, telecommunications, and multimedia.
6. There is a culture of collaboration that supports the distribution of knowledge.
7. A mythical/virtual entity (e.g., Wizard, *El Maga*, Golem) exists at each site to coordinate and mediate participants (Gallego, 2001, p. 316).

Additionally, and given the bilingual nature of *Los Árboles* participating students, UTSA

bilingual candidates and faculty deliberately provide a support system so that children could successfully respond to the cognitive and linguistic demands embedded in an after school project. Cummins (2000) proposed that in order to achieve a cognitive academic language proficiency, "programs should provide a focus on meaning, a focus on language, and a focus on use on both languages..." In other words, we know that students are developing cognitive academic language proficiency "if we can say with confidence that our students are generating new knowledge, creating literature and art, and action on social realities that affect their lives" (p.99).

Based on these principles, the researcher sought to answer the two research questions: What is the nature of inquires that children pursue when prompted to engage in a self-generated project in an LCM site? In what way do self-selected projects foster cognitive and linguistic development in two languages at an LCM site? The plan for the Spring 2012 semester included open-ended instructions to make sure that *aspirantes* and their *amiguitos* remained focused and were aware of important benchmarks/deadlines that were to be met during the semester (see Table 1). During each meeting, the prospective teachers and children decided the type of sub-activities that would be designed in order to accomplish the general goal.

## Social Design Experiment in LCM: Methodology

LCM spaces allow participants to engage in methodologies favorable to social transformation such as social design experiments. This approach, according to Gutiérrez and Vossoughi (2010) challenges university faculty and undergraduate students to "redesign the learning ecology so that ongoing opportunities for all participants to engage in robust learning practices are the norm" (p. 102). The context for experimentation in this case involved components such as a university-community partnership represented by UTSA-

Table 1

*Self-Selected Inquiry: Plan of Action*

| Week | Activity |
|---|---|
| 1 | Brainstorming session to figure out topic of inquiry project. Homework for all weeks: Share with parents. |
| 2 | Define you research project, make a plan, and include your guiding question(s). |
| 3 | Continue your research and explore at least two types of presentation software and choose one for your final presentation. |
| 4 | Guided inquiry day. Your UTSA amigo will involve you in an activity that further explores your research topic. |
| 5 | Continue working on your project. |
| 6 | Preliminary presentation for feedback purposes. |
| 7 | Revise and consider classmates' suggestions. |
| 8 | Continue working on project. Have you met your goals? |
| 9 | Final touches. Test technology. |
| 10 | Presentation and celebration: Sharing final product with classmates and parents. |

Table 1

*Los Árboles* Elementary school, parents, university faculty, a mystical figure or *El Maga*, and a maze or *laberinto*. This methodology also challenged faculty researchers to strategically intervene so that participants, in this case elementary students and pre-service teachers actively formulate and seek answers to their own questions. In these endeavors, "the subject is put in a structured situation where a problem exists and the subject is provided with active guidance toward the construction of new means to solve the problem" (Engestrom, 2008, p.2).

Social design experiment methodology permeated the design, implementation, description, and analysis of the results of a project in which a community of learners used a variety of resources to engage in scientific inquiry. In this exploration, the goal was not only to focus on resulting products, but to understand participants' contributions and how they made sense of this experience (Trout, 2008, p. 70).

For UTSA faculty participating in this project, part of this experiment included a deliberate infusion of open-ended tasks stemming from a student-generated inquiry. As a result, *aspirantes* would be able to engage in practices that are congruent with a pedagogy of possibility. specifically, actions such as the inclusion of student voices in the decision making process, that challenge deficit perspectives that often permeate both regular and after school curricular settings in low-socioeconomic neighborhoods (Gutiérrez, Bien, Selland, & Pierce, 2011). The researcher and participants were responsive to the context of learning and teaching and the changing conditions that occasionally emerge in today's public schools. A responsive approach to change was crucial through out the 10-week collaboration in LCM and allowed participants and the researcher to adjust the plan as needed (Merriam, 2009).

**Participants and Setting**

This qualitative inquiry, focused on a particular 10-week experience attended by a well defined group of participants (Merriam, 2009) including 26 *aspirantes* or bilingual teacher candidates and 25 elementary students from a local two way dual language elementary school in a predominantly Mexican neighborhood who met after school once a week for 10 weeks. Of the *aspirantes*, all identified themselves as Mexican and/or Mexican-American. There were a total of 24 female and 2 male *aspirantes*. All pre-service teachers were enrolled in a science methods course and a reading comprehension course which included participation in this after school program as partial fulfillment of the course requirements. UTSA *aspirantes* interacted in Spanish with children, but children used the language of their choice in oral and written communication.

Once a week, *aspirantes* spent two and a half hours with a child. These learning dyads remained constant the entire semester unless unforeseen circumstances (e.g., occasional absence, a pre-service teacher became ill, etc.) forced the formation of triads. This dyadic structure in LCM engaged children and prospective teachers in dialogic exchanges so that they could learn from each other, and just as importantly, this experience situated the

Table 2

*Participating LCM Children*

| Grades | Female | Male | Total |
|---|---|---|---|
| **K** | 3 | 1 | 4 |
| **1** | 1 | 0 | 1 |
| **2** | 2 | 3 | 5 |
| **3** | 0 | 2 | 2 |
| **4** | 7 | 3 | 10 |
| **5** | 2 | 1 | 3 |
| | | Total | 25 |

Table 2

prospective teacher in a position in which to learn about a child. Participating children included a total of 25 children whose grades ranged from kindergarten to fifth grade as shown in Table 2. This purposeful selection of site and individuals (Miles & Huberman, 1994) was necessary to understand the type of dynamics that take place in an after school setting.

### Data Collection and Data Analysis

Data included undergraduates' field notes, researcher's anecdotal notes, *El Maga* communication, children's responses to *El Maga*, and all completed projects. After each one of the meetings with their LCM *amiguito*, *aspirantes* completed weekly field notes that included descriptions of the setting, observations, and reflections related to what was observed. This separation of commentaries was critical so that actual observations were not confused with what pre-service teachers thought the observed event meant (Creswell, 1998). Children's notes were drawn from their communication with *El Maga*. In these notes, they often shared not only their progress in relation to the project, but their overall attitudes and perspectives towards their own learning. Finally, data collection included products presented at a culminating event in which students shared their inquiry or *Proyecto de Indagación* as they knew it. Themes were identified through constant comparison and continuously revised as the researcher grouped the data (Mertler, 2012). Although initial categories included broad concepts such as science from a social, personal, and practical perspective, a closer analysis and triangulation of data prompted the researcher to redirect attention to more specific themes that branched out of those initial umbrella terms. New categories included projects that related nature (e.g., animals and plants, and related concepts); inquiries related to earth science and a smaller number that addressed physical science concepts. The researcher also started with pre-established categories including cognitive and language domains. Within the cognitive domain, the researcher focused on open-ended activity and referred to Bloom's Taxonomy to code data. In the language domain the researcher coded the data based on Otto's types of language knowledge including phonological, morphemic, pragmatic, syntactic, and semantic (Otto, 2014).

The next sections present a summary of the type of inquiries conducted during the spring 2012 semester. Additionally, instances of cognitive and linguistic development are highlighted in the work of Laura and Myra, a pair that collaboratively worked on the topic of ladybugs and whose work serves to illustrate a patterns identified not only in this group, but throughout this experience at *Los Árboles* Elementary.

## Results

### Biophilia as a Pattern in Children's Inquiries

In this study, children overwhelmingly chose living organisms and life-like processes as the focus of their scientific inquiries. Sixteen students worked on projects which included questions related to plants and animals as illustrated in Table 3 (all names included in this manuscript are pseudonyms). This innate attraction or fascination that children expressed toward nature shaped the content, process, and format of their intended product. In the initial stages of the project, for example, student inquiries included: *¿Por qué les atrae la sangre a los tiburones? Quiero saber si pueden escuchar la música los perros* [Why are sharks attracted to blood? And I would like to know if dogs can listen to music]. Another student expressed: "*Me llama la atención saber como*

*los elefantes pintan como yo* [I am curious about elephants' ability to paint like me]." There were also some projects related to plants such as the one selected by a kindergarten student who indicated: "*La próxima semana voy a traer semillas de manzanas para sembrar las semillas. Quiero ver cómo crecen las plantas*" [Next week, I am going to bring apple seeds to plant. I want to know how plants grow].

In order to answer/solve their inquiries, students engaged in direct and indirect experiences with nature (see Figure 1). For example, students used their iPads and desktop computers to access internet websites, videos, and pictures related to their topic. The spontaneous attraction children feel and express towards living things is crucial not only from a social aspect, but as Kellert (2003) contended, "nature continues to provide young people with an unrivaled source of attraction, stimulation and challenge relevant in both emotional and intellectual development" (p. 123). This type of stimulation, Kellert also suggested, is inherent not only in direct experiences with nature but in the vicarious or symbolic experiences of nature that children access through print and electronic sources as it is the case in LCM.

Table 3

*La Clase Mágica Projects*

| Student | Grade Level | Title of Project |
|---|---|---|
| **Brianna** | 2nd | *Los perros que me gustan* [I like dogs] |
| **Melani and Juliana** | K | *Las Flores: ¿Qué puedo aprender?*[Flowers: What can I learn about them?] |
| **Everardo** | 2nd | *Los Tiburones* [Sharks] |
| **Maribel** | 1st | *Los elefantes pintores* [Elephants that paint] |
| **Rafael** | 4th | *¿De veras son asesinas las orcas?*[Are killer whales really assesins?] |
| **Adriana** | K | *¿Cómo crecen las frutas en las plantas?* [How does fruit grow in plants?] |
| **Ashley** | 4th | *Los Bulldogs* [Bulldogs] |
| **Laura** | 4th | *Las mariquitas y su hábitat* [Ladybugs and their hábitat] |
| **Gabriela** | 5th | *Los Bulldogs* [Bulldogs] |
| **Blanca** | 4th | *Los animales y sus diferentes hábitats* [Animals and their hábitat] |
| **Marco** | 2nd | *¿Son peligrosos los lobos?* [Are wolves dangerous?] |
| **Joseph** | K | *¿Por qué suceden los tornados?* [How do tornadoes happen?] |
| **Denise** | 4th | *¿Por qué tiene sal el agua del mar?* [Why is seawater salty?] |
| **Ana** | 5th | *¿Cómo es la luna?* [What is the moon like?] |
| **Alejandra** | 2nd | *Las nubes: ¿Cómo flotan en el cielo?* [Clouds: How do they float in the sky?] |

Table 3


*Figure 1.* Direct indirect, and symbolic experiences with nature.

During this experience, children's natural attraction to living organisms was not only an important stimulating and empowering factor but a driving force in engaging in active inquiry at complex levels as stated by Myrna, whose *amiguita*, Laura, decided to study ladybugs: "I learned that it is essential to take the children outside and just let them explore. By letting them be their own teachers, we allow them to ask questions and explore their curiosity." Self-initiated exploration resulted in children making observations, gathering data, and drawing conclusions.

**Taking a Closer Look: *Mariquitas* [Ladybugs]**

This section presents a closer look at the project Laura chose to pursue which revolved around the life of ladybugs (*mariquitas*). Laura was paired with Myrna, an undergraduate student

whose field notes described part of the first encounter. In that encounter Laura informed Myrna that she was a fourth grader who loved mathematics and writing and that she joined the LCM club when it began at *Los Árboles*, when she was in second grade. Myrna described their first encounter as a very relaxed session in which she tried not to be prescriptive or do the thinking for the student.

Participating in an informal learning environment in which students have a voice in the content, process, and product is an extremely unusual experience for teacher candidates. In their regular field placements, teacher candidates are generally expected to plan all aspects of a lesson including the learning outcomes, the introductory setting, the vocabulary, conceptual framework, guided practice, independent practice, and evaluation. All of this is standards-based and checked by their cooperating teacher and their university professor. LCM's informal environment on the other hand, promoted student choice, a crucial component in a project-based approach, which in its initial stage called for a brainstorming session that aimed at narrowing the initial focus (Katz & Chard, 2000).

For Laura and for Myrna, this was not an easy task. Laura started by trying to 'please the teacher' or as Myrna indicated in a field note: "*Cuando le pregunté a ella lo que le gustaba hacer para divertirse, me respondió que estudiar. Se me hace que no estaba pensando en cosas que le fascinaban sino en cosas que a una maestra le gustaría escuchar*" [When I asked her about what she liked to do for fun she replied that she likes to study. I think she was not thinking about things she loves to do, but about things that a teacher may want to hear]. Eventually, after taking sometime to get to know each other at a personal level, Laura indicated that if she was given an opportunity to learn about anything she wanted she would definitely choose *mariquitas* [ladybugs]. Laura's gravitation towards a living organisms, specifically an animal, is identified as an innate and historically embedded inclination in our cultures (Lawrence, 1993; Shepard, 1998; Wilson, 1993) as Wilson indicated, "these cultural forces give power to the analysis of animals' symbolic roles" (p. 332). Not surprisingly, a quick web search yielded an ample list of fiction and non-fiction children's books with ladybugs as a central topic (*Cinco Pequeñas Mariquitas* by Melanie Gerth and Laura Huliska-Beith and *La Mariquita Malhumorada* by Eric Carle, and Teresa Malawer among others).

## Cognitive Biophilia in LCM: *Mariquitas* that Inspire

Extending the concept of biophilia to the cognitive domain allows us to dissect the innumerable ways in which animals "are good to think" (Levi-Strauss as cited by Elizabeth Lawrence, 1993, p. 302). Lawrence (1993) proposed the term "cognitive biophilia" to emphasize the close connections between living organisms and human's thinking processes (Kahn Jr., 1997; Kellert, 1993; Wilson, 1993). Such affiliation, Kellert (1993) contended, naturally leads to engagement in activity that fosters cognitive, affective, and moral development. In LCM, this focus on learning and development centered on stimulating complex thinking by making connections to students' prior knowledge to construct meaning (Vasquez, 2003). In Laura's case, she drew from earlier encounters with *Mariquitas* to select this insect as the central topic of her inquiry project. To Myrna's surprise, Laura immediately engaged in discovery at high cognitive levels as shown by a guiding question that was both open-ended and complex: "How is one day in the life of a ladybug?"

Responding to that question in the context of an informal learning environment such as LCM is highly contingent of the affective

connection that intrinsically draws the student to the topic. Not surprisingly, Iozzi (1989) suggested that affection or inclination toward something, in this case nature, is the "key entry point in learning and teaching" (pp. pp. 6-13). By the third meeting, the enthusiasm level had been maintained. As Myrna indicated: "I noticed that her attitude towards the project is very positive and she enjoys learning more and more about ladybugs." Initially, Laura spent much of her time navigating through websites and books in English and in Spanish. This symbolic "experience with nature is an important aspect of this as well as other stages of cognitive development, often insufficiently appreciated and recognized" (Kellert, 2002, p. 123). It was during weeks four and five that Laura and Myrna had gone through the books and learned among other things that "ladybugs eat aphids, which were usually found in farms. We also found out that during spring time, they are most likely mating and in form of eggs." With this, Laura generated an additional question. She wondered if some leaves with nibbled sections were the sign of the presence of adult ladybugs somewhere near the inspected area: "*Sigo aprendiendo mucho de las mariquitas y también tomé fotos de unas hojas que un insecto (a lo mejor una mariquita) había comido*" [I continue to learn a lot about *mariquitas* and I also took pictures of some leaves that an insect (perhaps a ladybug) had eaten]. She also wondered if "lady bugs' spots match both sides of their body" symmetrically.

***Four Ladybugs: A Day to Celebrate!***

By week seven, Laura continued thinking and talking about *mariquitas*, but this time with active contribution from her parents. From its inception, this student-generated inquiry included parental involvement as a key feature. Regardless of parents actual attendance at weekly meetings, LCM faculty designed a take home assignment in which parental input was requested in their children's projects with the heading: "*Hola Papás, Necesitamos su Ayuda*" [Hello Parents, We need your Help]. This particular time, Myrna sent a ladybug box kit home and asked that they contribute to Laura's project by looking for ladybugs as a family. At the beginning of meeting seven, Laura surpassed all expectations when she announced: "Miss, not only did I find one ladybug this week, but I found four and three of them do not have spots!" She explained how her father was key in actually catching them. Although proud and excited about being able to observe them closely, Laura anxiously asked if Myrna could go to the garden to free all ladybugs. This positive affiliation with *mariquitas* had been enhanced not only by this direct experience, but by the sum of all encounters including symbolic contact through readings. Shepard (1998) argued that intellectual development of children is closely tied to their empathetic encounters with *nature*, such as Laura's experience in catching and releasing these insects: "As we observed the ladybugs, one by one we let them go, and her face lit up with joy. She felt the freedom the ladybugs got as they flew away," wrote Myrna. Through her observations, Laura, documented similarities and differences among the three captured ladybugs, leading her to conclude that ladybugs were not necessarily symmetrical and that they came in different colors, including hot pink, which highly surprised Laura who began sharing much of this knowledge through conversations with other LCM children and with *EL Maga*.

**Linguistic Biophilia: The Semantic and Pragmatic Intricacies of Social and Academic Language Knowledge**

Congruent with Lawrence (1993) who defined cognitive biophilia as a construct that underscores how "symbols and images of nature are often used to facilitate human intellectual development (p. 123), Shepard's (1998)

argument emphasizing the "importance of animate nature as a facilitator of human language and thought" (p. 51) extends this argument. In LCM, engagement in self-selected science projects facilitated by and with an undergraduate *amigo* resulted in numerous opportunities to develop language organically. This section focuses on the opportunities that LCM provided to develop pragmatic and sematic knowledge of language. Children's natural inclination to associate with nature favored acquisition of semantic knowledge of language (Otto, 2014) as illustrated in Figure 2. Basically, when the adult (more knowledgeable other) or addressor connects living organisms or objects in nature (referents) with verbal symbols (words), they contribute to the process or symbol formation. This natural gravitation towards animals, for example, in early infancy can potentially be the source of a long list of labels that include: head, feet, body, fur, soft, eyes, mouth, whiskers, dogs, cat, bird, tree, bark, leave, bark, sing, among others. This word bank becomes a permanent part of the child's linguistic repertoire and is accompanied by morphemic and syntactic knowledge when the adult purposefully utilizes more complex sentences.

Direct experiences in which children had an opportunity to engage their senses were crucial at the onset of the project. Kellert (2002) suggested that direct experiences with nature provide opportunities to touch, smell, see, hear, and taste, but also to hear and produce simple and complex vocabulary. As Myna became immersed in her project she began using terminology reflective of knowledge and skills in science. The biophilia hypothesis was important in explaining the important role that plants and animals play in the process of symbol formation. Otto (2014) explained that when adults purposefully comment, share, dialogue or hold a conversation with children related to an object or referent, they contribute to the acquisition of a variety of labels, or words that associate sound and meaning. Table 4 includes a list of words used by Laura as she explored through both direct and indirect experiences with nature:

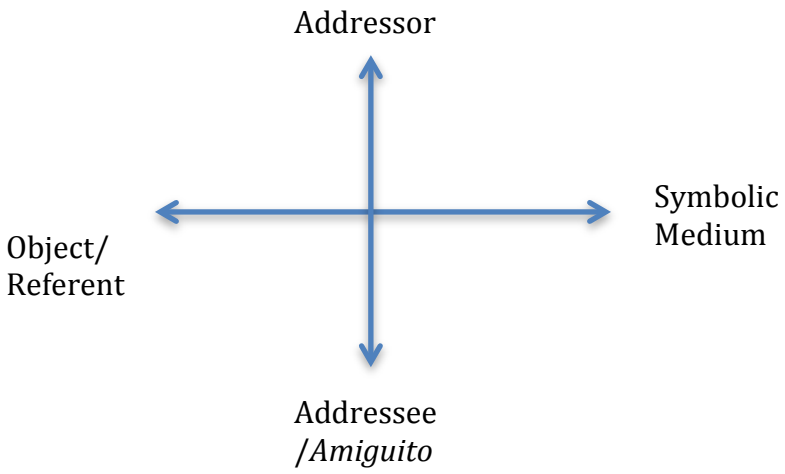


*Figure 2*. Components of Symbol Formation

Table 4

Science Vocabulary used During the Duration of the Project.

| Vocabulary used in Laura's communication with *El Maga* generally in Spanish | Vocabulary Laura shared with Myrna in English and Spanish | Vocabulary used in the final product (PREZI) in Spanish |
|---|---|---|
| *Proyecto de indagación* [Inquiry project] | Life | *Investigación* [investigation] |
| *Retraer* [retract] | Prezi | *Sobrevivencia* [survival] |
| *Cabeza* [head] | Leaf | *Observaciones* [observations] |
| *Cuerpo* [body] | Nibble | *Conclusión* [conclusions] |
| *Sensores* [sensors] | Aphids | *Datos* [data] |
| *Olfato* [smell] | Farms | *Brillo* [shine] |
| *Ciclo* [cycle] | | *Predador* [predator] |
| *Etapa* [stage] | | *Patas* [legs] |
| *Huevo* [egg] | | *Antenas* [antennae] |
| *Larva* [larva] | | *Afidos* [aphids] |
| *Pupa* [pupa] | | *Plantas* [plants] |
| *Adulto* [adult] | | *Hojas* [leaves] |
| *Hojas* [leaves] | | *Actividad* [activity] |
| *Insecto*[insect] | | *Luz* [light] |
| *Reflejo* [reflection] | | |

Table 4

**Pragmatic Knowledge of Language while Learning Science**

Though their interactions in the context of LCM, children learn how to adjust language to address a variety of situations and individuals with whom they come in contact. This pragmatic knowledge of language "involves the knowledge or awareness of the overall intent of communication and language is used to achieve that intent" (Otto, 2014, p. 10). During any regular session at LCM, children interacted orally and in writing with their undergraduate *amigo* or *aspirante*, their friends, university faculty, and *El Maga*. Communication with this mythical figure for example was always friendly and informal as illustrated in Figure 3. This particular semester *El Maga* purposely inquired about children's self-selected projects.

*¡Hola Laura!!!!!,*

*¿Cómo estas?*

*Feliz día del amor y la amistad!!!!!!!!!!!!*

*...me da mucho gusto volver a escribir cartas... y me da más gusto el poder escribirte a ti como parte de La Clase Mágica...*

*Yo estoy súper emocionada de empezar un nuevo semestre con todos los niños de La Clase Mágica...*

*Este semestre espero que tu jornada por el laberinto mágico te guste mucho porque va a haber un proyecto padrísimo que espero que te guste!!!!...*

*Espero tu carta, ¿ok? Cuídate mucho y diviértete mucho en La Clase Mágica...*

*Hasta luegooooooooo!!!!!*

*El Maga*

[Hello Laura!!!! How are you doing?

Happy Valentine's Day!!!!!!!!!!!!

...I am so glad to write letter again...and I am happier to be able to write to you as a member of La Clase Mágica...

I am thrilled to begin this new semester with all the children at La Clase Mágica...

This semester I hope you like your journey through the magic maze because we will have a very cool project that I hope you like!!!!...

I will be expecting you letter, ¿ok? Take care and have fun at La Clase Mágica...

See you later!!!!!!!!!!!!

*El Maga*]

*Figure 3*. *El Maga* letter

As Laura's project progressed, she continued to engage in the complex skill of navigating social and academic language situations while completing her project. These skills are needed, Otto (2014) asserts, if children are to identify situations or an immediate "awareness of the specific ways in which academic language is used" (p. 10). Laura's intrinsic motivation to carry out her project fueled her initiative to seek information from library books and electronic sources generally characterized by an academic discourse. Academically, Myrna's notes reflected Laura's growth in different ways: "I noticed that Laura was picking up facts about ladybugs to answer broad concepts that covered the ladybug cycle, ladybug anatomy, and the life of a ladybug. . . I can tell that her attitude, if it is continued will get her to college." Her Prezi slides for example, were tailored for an expected audience that included teachers, students, parents, and *aspirantes*. In this piece and using formal academic language, Laura added concrete points that summarized her learning about ladybugs up to that day (see Figure 4).


*Figure 4*. Synthesis of a lady bug's life cycle.

Parallel to summarizing her learning, Laura adapted her discourse as she again engaged in communication with *El Maga,* and while explaining the life cycle of a ladybug she concluded her letter by adding that "*Hoy mi día fue muy chidísimo en La Clase Mágica*" [My day was super cool at LCM], to which *El Maga* responded: "*. . . a ver, dime por qué tu día fue chidísimo!!! Cuéntame, anda!!!! . . . y que te han dicho tus papás de tu proyecto, te están ayudando? Cuenta, cuenta!!!* [Let's see, tell me why your day was super cool!!! Go on, tell me!!! . . . and what have your parents said about your projects, are they helping you? Tell me, tell me!!!]. Historically, *El Maga* has developed a relationship with children that blurs the line between the formal and the informal, the academic and the social.

**Celebrating the Completion of the Project with a Real Audience**

Congruent with a project-based approach in which students have an opportunity to present to a real audience, parents, school staff, and university professors were invited to a presentation of students' final products which included i-movies, power point presentations, posters, demonstrations, and Prezis. Laura decided to prepare both, a poster and a Prezi (see Figure 5). According to Myrna's notes:

> Laura presented and she had such a confidence that she made it seem interested. I loved the way she spoke, very clear and informative. She showed her videos over her results in the field. I thought she was amazing and silly with the way she presented the project. She was also excited to show her mom the trifold that we created. She explained everything, in detail.

Laura synthesized in a Prezi all the information learned over the period of ten weeks and added other facts including cultural perceptions of ladybugs as insects that signal good luck; the fact that there are over 500 types of ladybugs in the United States, their bright colors may help in scaring predators away; they have six legs; not all ladybugs are 'ladies'; their body expands or puffs up when they get ready to fly; they have two antennae; their diet consists of aphids, plants, and leaves; they can live up to a year; they are active during the day and sleep at night, when they do not respond to light; and not all of them have spots.


*Figure 5*. Inquiry project: Laura's final presentation

## Conclusions

LCM's informal learning designs such as those implemented at *Los Àrboles* Elementary allowed faculty and prospective educators to experiment pedagogically with equity aims in mind. The social design experiment described in this article yielded opportunities to tap into children's scientific interests while engaging them in project-based activities. As a result, final products reflected a biophilic inclination that resulted in active exploration of nature related topics. The intrinsic motivation or affective tie to a self-selected topic in LCM immersed all participating children in a journey that allowed them to navigate social and academic situations seamlessly while significantly enhancing their vocabulary in both languages. Laura's experience demonstrated that when given the opportunity, children naturally surpass disciplinary barriers and show us that complex connections and academic language proficiency are the result of authentic opportunities to learn.

Too often, project-based approaches are perceived as time consuming and unrealistic in today's accountability era. On average, Laura spent 90 minutes a week dedicated to interest-based inquiries and was empowered to gain knowledge, synthesize, evaluate information and communicate her findings. Through science, she developed pragmatic, sematic, syntactic, morphemic, and phonological knowledge of two languages. These opportunities for cognitive and linguistic engagement can be present in all classrooms when spaces for student choice are provided.

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