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Arts Integration and Culturally Sustaining Pedagogy: Supporting Bi/Multilingual High School Learners in Biology

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ABSTRACT

There has been a dramatic increase in the number of multilingual and multicultural students in U.S. schools. Because of high-stakes testing and English-only mandates, instructional practices and curricula in most urban school districts neglect the cultural and linguistic interests of their diverse student populations. In this interpretive study, we use exploratory case study methods to demonstrate how Culturally Sustaining Pedagogy (CSP) and Arts Integration (including drawing and graphic story with Photoshop) can support the learning of ten students whose first language is not English. This article introduces research activities supporting the use of culturally sustaining pedagogy and arts in a biology unit (the role of selection population) in communication skills class, particularly with bilingual and multilingual youth.

Keywords: Arts Integration; bi/multilingual learners; biology unit; communication skills class; culturally sustaining pedagogy; STEAM

INTRODUCTION

Arts integration gained attention in the 1960s and 1970s when arts partnerships among community arts organizations and public schools became common (Dreeszen, April, & Deasy,1999; Remer, 1996;). The Arts Education Partnership (2002) reflected a growing trend involving public schools, arts organizations, and universities. While not all partnerships included in the AEP documents focused on arts integration, the growth of sustained connections between art education and other disciplines contributed to the discussion of arts education in other classrooms (Burnaford, Brown, Doherty, & McLaughlin, 2007).

Art educators have long promoted interdisciplinary art education and arts integration (Stokrocki, 2005). Silverstein and Layne (2010) define arts integration as "an approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in a creative process that connects an art form to another subject area and meet evolving objectives in both" (para. 3). Arts integration has been used to explore "the relevance and approaches to arts education connected to curriculum and instruction with learners of all ages, including teacher-learners" (Cahnmann-Taylor & Sanders-Bustle, 2019, p. 2). Arts integration can tie together the many components of the other disciplines. Moreover, it addresses the importance of creative production and promotes hands-on learning through artmaking as a powerful way for students to express themselves as learners and to recognize themselves as engaged in meaningful learning.

Collaborative Interdisciplinary Pedagogical Development and Implementation

As media art (digital art, computer graphics, computer animation, 3D, etc.) has become more widely available and accessible, it has fundamentally changed the way people communicate and compose. Many scholars have reported that media art, as a multimodal process, motivated students to do well with the school curriculum. For example, Bruce (2009) found that students in his elective media course were more motivated to create digital films than traditional print-based assignments. Similarly, Chandler-Olcott and Mahar (2003) maintained that the students who worked on anime and webpages of their own free will spent many hours crafting and revising their respective multimodal texts. Lawrence, McNeal, and Yildiz (2009) found that creating online comics was engaging for their students and improved their information literacy skills. For the students he worked with,

Nixon (2009) found that digital storytelling promoted agency, social awareness, and literacy.

Similarly, in *Art as a Way of Talking for Emergent Bilingual Youth: A Foundation for Literacy in K-12 Schools* (Berriz, Wager, & Poey, 2019), contributing authors share inspiring examples illustrating how arts and culture functions as a foundational literacy for emergent bi/multilingual students. Multimodality emphasizes how the many different modes within any given text intersect, interrelate, and are interpreted to make new meanings (Kress, 2000, 2003). For example, Sally Brown (2019) uses digital artwork that employs images as tools for student discussion to develop an understanding of emergent bilingual (EB) students as designers and writers. In Brown's research, which lasted an entire school year, multilingual students at an elementary school composed 26 books that incorporated text and digital art addressing four themes: "friends and family, holidays, popular culture (e.g., TV shows and video games), and animals" (p. 168). Each student integrated cultural perspectives that represented his or her life experiences to express his or her culture in narrative stories.

Through graphic novels, Jie Park and Lori Simpson (2019) engage EB high school students' critical and analytic ways of "reading" their world by supporting the development of their "critical multiliteracies" (Jewitt, 2008) through integrating arts (the graphic novel) into their teaching practice. "The arts in graphic texts promoted a different kind of reading—a kind of reading in which language-learning youth became active inquirers and critical analysts, questioning who created the text, with what intention, and with what beliefs, and worldviews" (p. 246). Hence, arts, including media arts, are significant because they cultivate the brain processes involved in knowledge acquisition and foster the higher-level skills of learning, knowing, thinking, remembering, and problem-solving that are necessary for understanding concepts more deeply.

From STEM to STEAM: Getting an A in STEM

The emphasis on STEM (Science, Technology, Engineering, Mathematics) in the U.S. began with the launch of the Russian satellite Sputnik in 1957 (Erwin, 2017). Over the next 50 years, the National Aeronautics and Space Administration (NASA) was created, science and engineering firms were launched (leading to the first cell phone, first personal computer, and first permanent artificial heart), and numerous councils related to math and science were formed to guide K-12 curricula. The first explicit use of the STEM acronym arose during a 2005 Congressional caucus advocating the creation of schools focused on science and engineering (Heitin, 2015). That same year, the National Academies of Science, Engineering, and Medicine indicated that U.S. students lacked proficiency in STEM compared to students from other countries (Erwin, 2017).

Currently, only 16 percent of American high school seniors are proficient in math and interested in STEM careers (U.S. Department of Education [DOE], 2015), and bi/multilingual learners are severely under-represented in STEM fields (National Academies of Science, Engineering, and Medicine, 2016).

In 2007, STEAM (Science, Technology, Engineering, Art, Mathematics) education emerged as a new pedagogy during a roundtable discussion on national policy by Americans for the Arts in response to the need to increase student interest and skills in science, technology, engineering, and mathematics (Perignat & Katz-Buonincontro, 2019). STEAM is "an interdisciplinary or transdisciplinary approach to teaching and learning . . . in a defined learning context" (Perignat & Katz-Buonincontro, 2019, p. 34). Today, the DOE's goal is to prepare more than 100,000 new STEAM teachers by 2021" (Erwin, 2017). While there is much interest in STEAM among researchers and educators, limited information is available regarding how instructional approaches must shift if STEAM teaching is to be effective in improving students' math and science competencies. Moreover, it requires a shift from traditional education methods to a focus on the learning process (NGSS Lead States, 2013).

One misconception about STEAM education "is that [the] arts [are focused] primarily on a finished product, rather than a process of learning through thinking, planning, and creating a work of art" (Perignat & Katz-Buonincontro, 2019, p.33). Engaging in art as a process of learning (Duggan, 2007; Patterson, 2015) is essential to facilitating learning in other disciplines, specifically STEM.

Arts Integration in STEAM Classrooms

There are several models for employing arts to strengthen STEM skills. Some artists blur the boundaries between art, design, and STEM disciplines by including science in their artwork in order to demonstrate that art can help people understand more about the artistic/creative process inherent in thinking about design, as well as the value that aesthetic inquiry can add to the sciences. In fact, "when the arts are seen as an end goal, not just an entryway to presumably more important STEM topics, thoughtfully developed STEAM curricula can truly engage sustained cross-disciplinary student learning in K-12 settings and informal education" (Bequette & Bequette, 2012, p. 43). Moreover, integrating arts into STEM may be a promising method for teaching problem-solving and creative and critical thinking. In fact, strong connections between art and STEM can be made when examining large and complex ideas, concepts, practices, and habits of mind (Hetland, Winner, Veenema, & Sheridan, 2007; Wiggins & McTighe, 2005).

Giving students opportunities to view and create art encourages them to think critically and introduces them to the power of art. For example, a lesson on using watercolors could incorporate science by asking students to explore the

effects of watercolors on different types of paper or by asking them to mix materials into water colors. In the process, learners will then be able to create their own artwork that is deliberately informed by their understanding of scientific concepts (Glass & Wilson, 2016). Schramm (2000) describes a class at Madeira Jr./Sr. High School in Cincinnati, Ohio, in which high school art and biology students integrated art with biology to create a three-dimensional genetic robot. The project was designed "to recognize individual differences in students while providing the conditions and experiences by which all students become visually and scientifically literate" (p. 41). In this class, students explored 19th-century Mendelian genetics and studied 20th-century video-sculptures by Nam June Paik. The students engaged in discovery learning through a hands-on approach as well as through memorizing isolated facts. As a result, they could make connections between the arts and science by drawing on their experience.

Metcalf (2004) describes a "lesson "designed to encourage high school students to see connections between art images and physics principals" (p. 25) in which students were shown four images by artists Lynda Lowe, Richard H. Love, Victor Vasarely, and Richard Pousette-Dart and then asked to create a visual representation of a scientific principle of their choosing using painting, drawing, or collage. Students were also required to write two paragraphs describing their artwork, how it fit the scientific principle, and how they would evaluate their success with this assignment. The significance of this study lies in its finding that integrating visual art with physics improves student achievement and provides the opportunity for deeper learning and more meaningful, relevant instructional tasks.

Another example of integrating arts into science content is SLANT, "a platform for exploring the connections between contemporary art and science and creating innovative ways to integrate and teach K-12 students" (Marshall, 2017, p. 139). SLANT created a team of representatives from the San Francisco Unified School District (SFUSD), the California Academy of Science (a natural history museum), and the M. H. de Young Memorial Museum (a fine arts museum). As Marshall (2017) describes, SLANT was "a year-long program with multiple sequential workshops" that organized participants "into cohorts of 30 to 40 teachers who worked together over an entire year" (p. 145) with the goal of designing a curriculum that would deepen understanding of scientific and artistic concepts and practices as well as developing teaching strategies that "foster and embody openness, flexibility, and curiosity in students" (p. 140). Similarly, Marshall (2010) provides evidence that integration is a significant, lively, and authentic art practice that offers teachers and students in high school practical ways to connect art with curricula. Marshall presents five models for teaching art in ways that accommodate integration: Depiction, Extension/Projection, Reforming, Mimicry, and Metaphor. The models are based on five conceptual strategies used by contemporary artists Alexis Rockman, Mark Dion, and David Wojnarowicz to

manipulate ideas and imagery in order to make meaning. According to Marshall (2010), "by providing ways to integrate art that are based on contemporary art practices and showing that art and integration go hand in hand, these strategies testify that learning through the arts is compatible with learning in the arts" (p. 19).

Marshall also illustrates the qualities of arts integration as a transdisciplinary study by "viewing arts integration through the lenses of Systems Theory and the New Sciences, [which] reveals its potential as a pedagogy of fusion and flow that could transform teaching and learning across the curriculum" (Marshall, 2014, p. 104). She uses the example of Jenna Huxley, a senior in Kimberley D'Adamo's International Baccalaureate (IB) art class at Berkeley High School in Berkeley, California, who researched human-animal relationships by taking a trip to the zoo. Huxley used language arts to examine the anatomical similarities and differences among animals in terms of humans' scientific inquiry: "She invented her own set of symbols and a communication game, Lexigram, and experimented with the artwork of her classmates" (p. 110). Jenna's images and reflections reveal how she compared and contrasted thinking and imagery in biology studies and showed how disciplinary thinking provides the context for understanding the integration that a transdisciplinary approach implies (Marshall, 2014). Huxley's project enables us to imagine how transdisciplinary arts integration could inspire new models of practice in an education system. It also suggests that arts-integrated instruction might be particularly beneficial for students who are not best served by traditional teaching methods. It also enables us to imagine how transdisciplinary arts integration can create opportunities to alter the way educators in a variety of disciplines—including art—understand arts integration.

Leysath and Bronowski (2016) found that students have fewer opportunities to demonstrate learning when schools adopt a narrow focus on numeracy and literacy. Integrating art into other disciplines creates an opportunity for "deeper instruction, learning that is more meaningful and has a greater social understanding, and a more interesting and complex view of the world" (p. 29). An art teacher in the educational leadership doctoral program at Lamar University and the chemistry teacher at an East Texas high school explored leadership in curriculum and instruction design by using ceramics to teach core concepts in chemistry. In order "to discover shrinkage rates as well as the percentage of water absorption" (p. 30), students made slabs of clay, then weighed them. The tiles were fired to bisque and then placed in water overnight. The next day, students re-measured the mass to determine water absorption percentages. Through throwing a bowl on the pottery wheel and then glazing it, students were able to explore the properties of clay as well as develop measuring skills (Leysath & Bronowski, 2016). To determine the success of the arts integration in this project, researchers developed and collected a series of interview questions for the chemistry teacher

and a focus group of five chemistry students. Additionally, the chemistry teacher made observations during one of the activities. Finally, the chemistry teacher assessed students' understanding of benchmark concepts. The data showed "all of the participants shared the perception that the learning activities provided motivation and student responsibility for learning and improved academic achievement" (p. 32). The chemistry teacher reported that scores on Curriculum-Based Assessments, given at the end of each grading period, improved from previous years. Formative assessments, such as "(1) the time necessary to use concepts for further learning; (2) student use of concepts to complete assignments; and (3) student questioning further indicated an increase in student understanding of the chemistry concepts that were taught as art-integrated learning activities" (p. 33). Arts integration increased student engagement, and, moreover, the hands-on activities increased the relevancy of the lessons to the students. They all agreed that the activities were fun.

Curriculum development has become concerned with providing students with the skills necessary to thrive in a globalized economy. Hadinugrahaningsih, Rahmawati, and Ridwan, designed a two-year plan to develop students' 21st-century skills in the chemistry classroom through STEAM integration. "The term '21st-century skill' is generally used to refer to certain core competencies such as collaboration, digital literacy, critical thinking, and problem-solving that advocates believe schools need to teach"; such skills require students to "master content while producing, synthesizing, and evaluating information from a wide variety of subjects and sources, with an understanding of and respect for diverse cultures" (Hadinugrahaningsih et al., 2017, p. 1). The study, conducted at one private and one public secondary school, introduced the topics of hydrocarbons, petroleum, solubility, and the acid-base scale. For example, students performed tests to determine the best pH conditions for both goldfish and hydroponic plants in a classroom aquarium.

Similarly, Arís and Orcos (2019) consider the role of STEAM skills in the FIRST LEGO League championships. The development of educational robotics (ER) and its application in the classroom have grown in popularity due to the development of competitions such as the FIRST LEGO League, which aims to promote scientific and technological vocations through innovation, creativity, and teamwork. The FIRST LEGO League competitions have been held in Spain since 2006 and draw child participants from more than 70 countries. Every year, students with different abilities and interest levels participate in these competitions.

Empirical studies such as those described above illustrate the vital need to integrate arts into STEM in order to enhance student academic achievement, interest, engagement, critical thinking, creativity, self-expression, and problem-solving. However, each of these two studies has weaknesses. The arts-integration in the study by Hadinugrahaningsih and colleagues was limited to decorating the

aquariums. The goldfish aquarium project could have incorporated additional elements to engage students in critical thinking, communication, and other 21st century skills. For example, works by contemporary artists could have been introduced, and the process could have been animated with computer design software such as Minecraft. Also, while the authors believe that the use of LEGO bricks in the classroom or in competition can be effective in engaging students, Arís and Orcos did not sufficiently examine how the FIRST LEGO League might promote scientific curiosity as well as social skills, which can develop students' motivation and teamwork. Research is needed that investigates how arts integration can foster collaboration, leadership, and information- and media-literacy in addition to the benefits already identified.

By engaging students in activities that develop cognitive skills and foster higher-level learning (knowing, thinking, remembering, and problem solving), the arts help students attain a deeper understanding of concepts. This, in turn, is vital in encouraging students to envision new possibilities in their academic and professional careers. However, despite the clearly rich and valid cross-curricular benefits among the arts and STEM, making those connections may become a task specifically for STEM and art educators.

Cultural Relevance in STEAM

Considering the diversity of students in the United States, teachers must incorporate culturally relevant teaching (CRT) to provide a more equitable situation for their students. In 2016, a team of college faculty members collaborated to create an innovative multimodal approach to teaching STEAM as a professional development. The professional development approach had five sections: (1) storytelling examples, (2) integration of the arts into STEM, (3) technology, (4) CRT and storytelling, and (5) participant showcase. It was designed to unpack the process by introducing techniques, procedures, methods, and pedagogies using the arts, creatively exploring STEM subjects, and considering how CRT practices could be applied. The workshop provided educators with the practices to help students develop academic knowledge "through artmaking and storytelling; gave students the voice or the cultural competence to approach standards in ways that make the information relevant; and used artmaking as a means for students to develop a socio-political consciousness and evoke change" (Hunter-Doniger, Howard, Harris, & Hall, 2018, p.50).

Including culturally relevant enrichment activities is one way to encourage more interest among, for example, Native American students in science, technology, engineering, and mathematics (STEM) courses and careers. Using case studies along with Critical Theory, Liberation Theology, and Social and

Cultural Capital Theory, Kant, Burckhard, and Meyers (2018) explored the impact of combining traditional Native arts and crafts with STEM. "The goal of the activities was to deepen STEM interest and to demonstrate relevance to the participants' daily lives and community well-being, in the hope that some of the girls would consider STEM majors and careers in the future" (Kant et al., 2018, p. 15). The girls at Flandreau Indian School (FIS) were introduced to "native plants and glassmaking because of the central importance of native fruits and glass beads in traditional Native American life in South Dakota" (p. 18). The students identified over 100 characteristics of fruits and plants with traditional uses. The group made wild rose petal perfume, and each girl tagged a plant in the FIS herbarium with her name to personalize the experience and create a sense of legacy. The group also explored different glass manufacturing techniques through hands-on work, making "traditional Lakota/Dakota glass beadwork and porcupine quillwork using brain-tanned hides, rawhide, sinew, Giant Canada Goose feathers, ermine pelts, box turtle shells, horsehair, and many other authentic materials" (Kant et al., 2018, p. 19). The techniques used to gather data included a two-part post-survey and a post focus group of participants. Data analysis indicated that "culturally relevant STEM enrichment activities combined with Native arts and crafts increased interest in STEM studies and careers for Native-American high school girls in this situation at this place, although mathematics remains somewhat problematic" (p. 22).

Each of these conceptions of culturally relevant literacies in STEAM acknowledges that students, especially emergent bi/multilingual students, bring a range of resources from culture and home language to meaning-making in and outside of the classroom. These multiple forms of literacies challenge traditional forms of schooling that exclusively spotlight restrictive print- and language-based notions of literacy.

Bi/Multilingual Learners

Educators and teachers have documented the positive outcome of arts integration into other disciplines for speakers of other languages (Aghasafari, 2019). According to the National Center for Education Statistics (2016), 9.6 percent of students in the United States currently are classified as bi/multilingual English learners. Although relatively uncommon in the United States, bi/multilingualism is the norm worldwide. Between 60 and 70 percent of the world population is at least bilingual (Martínez, 2018). In other words, speaking two or more languages is the typical human condition. Immigrants and US-born Latinx children who attend schools in the United States must learn English in order to achieve academic success. However, many older immigrant children often feel marginalized and alone at school because of cultural differences and the difficulty

of language acquisition. Additionally, "anti-immigration policies and practices in 2010 and 2011 further challenge bilingual students" (Harman & Varga-Dobai, 2012, p. 2) and cause high anxiety.

Current science education pedagogy clearly emphasizes the integration of knowledge and skills in the real-world setting (NGSS Lead States, 2013). However, science is most often taught in isolation from other subjects and from daily life, making students feel that science is irrelevant to them. Also, students are expected to interpret visual images as they interact with the text, but this skill is sometimes neglected in the school curriculum. Improving visual literacy will empower all students, not just bi/multilingual students, by creating a vehicle for understanding and communicating about natural phenomena. In particular, the arts can become a tool for "academic development, personal and community identity development, and social change/justice" (Chapell & Cahnmann-Taylor, 2013, p. 250) by challenging traditional forms of schooling that rely exclusively on restrictive print- and language-based notions of literacy. Berriz and colleagues (2019) assert that "the arts are more than an added benefit in any educational context; they are foundational literacies that engage participants in the process of observing, connecting, finding solutions, making meaning, and communicating/expressing" (p. 12). In essence, the "aesthetic languages" of the arts disciplines (e.g., media arts, visual arts, theatre, gesture, image, sound, writing, music, etc.) become meaning-making (Aghasafari, 2019) tools to help achieve empirical goals that can help educators better understand students' experiences in the classroom.

Theoretical Framework

The Language, Culture, and Teaching series has published more than two dozen titles that reflect a commitment to providing quality texts to educators who are responsible for the education of young people in our increasingly diverse and complex society. Gloria Ladson-Billings defines culturally relevant teaching as a "pedagogy of opposition, not different critical pedagogy but specifically committed to collective, not merely individual, empowerment" (1995a, p. 160). Culturally relevant teaching must include cultural integrity as well as academic achievement, and it must meet three criteria: "students must experience academic success, students must develop and/or maintain cultural competence, and students must develop a critical consciousness through which they challenge the status of the current social order" (Ladson-Billings, 1995a, p. 160).

Ladson-Billings (1995b) inspired teachers and educators to make teaching and learning relevant and responsive to the languages, literacies, and cultural practices of multicultural and multilingual students (Paris, 2012). Culturally relevant pedagogy (CRP) aims to use the connections between culture and

curriculum, home and school to enhance students' academic achievement (Baker & Digiovanni, 2005). Students in a culturally relevant classroom learn different ways of understanding and presenting class content. Diverse views give students the opportunity to experience different interpretations and perspectives and to use their strengths in the development of new skills. Hence, CRP requires

> tapping into a wide range of cultural knowledge, experiences, contributions, and perspectives. Emotions, beliefs, values, ethos [sic], opinions, and feelings are scrutinized along with factual information to make curriculum and instruction more reflective of and responsive to ethnic diversity. However, every conceivable aspect of an ethnic group's culture is not replicated in the classroom. Nor are the cultures included in the curriculum used only with students from that ethnic group. Culturally responsive pedagogy focuses on those elements of cultural socialization that most directly affect learning. (Gay, 2000, pp. 31–32)

Ladson-Billings and other researchers developed Culturally Sustaining Pedagogy (CSP) in order to modulate culturally responsive pedagogy (CRP) (Gay, 2000; Ladson-Billings, 1995a; Paris, 2012; Paris & Alim, 2017). CRP views "linguistic, literate, and cultural pluralism as part of the democratic project of schooling" (Paris, 2012, p. 93). Pedagogy needs to do more than be "responsive or relevant to the cultural experiences and practices of young people—it requires that [teachers] support young people in sustaining the cultural and linguistic competence of their communities while simultaneously offering access to dominant cultural competence" (Paris, 2012, p. 95). Culturally sustaining pedagogy strives to incorporate the languages and cultures of students while also taking "a critical stance toward and critical action against unequal power relations" (Paris, 2012, p. 95).

CSP challenges educators to regard students' cultural and linguistic ranges as a resource to be integrated into the classroom curriculum. CSP supports the multimodal and verbal reports that bilingual learners need in order to make meaning in the sciences and other subject areas. When students are encouraged to write, and talk in class, they gain understanding through active participation with peers and teachers that later can be applied to new tasks, such as writing about or enacting a scientific principle. Moreover, teachers who engage with students are able to see more clearly how their students have applied their new knowledge in completing assigned work (Fang et al., 2014).

A common misinterpretation of CSP among teachers and educators is thinking the classroom or other environments should match students' home countries, which results in teachers feeling that they cannot integrate each student's culture into a diverse classroom. However, "instead of viewing culturally

sustaining instruction as matching classrooms to home practices, teachers might consider deliberately drawing from contrasting worldviews" (Puzio et al., 2017, p. 224). Furthermore, "establishing positive relationships with students, families, and communities" is "a critical element of culturally sustaining teaching" because understanding students' communities can help educators determine how best to implement CSP (Puzio et al., 2017, p. 224). This approach to educating students represents the foundation of this study.

RESEARCH METHOD

In order to demonstrate how CSP and arts integration can be utilized to support the learning of students whose first language is not English, this qualitative study uses the exploratory case study method (Creswell, 2012, 2013; Yin, 2014) with ten bi/multilingual students at a mid-sized public high school located in the southeastern region of the U.S. Our research team includes two experienced high school biology English Second Language (ESL) teachers and a doctoral candidate in art education.

Participants

The bounded system (case) for our study was a communication skills class at a mid-sized public high school located in the southeastern region of the U.S. The class was made up of 20 language learners born in eight different countries and ranging from 14 to 18 years of age. As most of the students were newly arrived in the country and had very limited English skills, the fundamental tasks of this class were to help students succeed academically and develop a confident and stable sense of self. The sample selection criteria for this study were bi/multilingual students in both the communication skills and biology classes. Ten students participated. In the interest of brevity, we report findings from four students.

Procedures

Art was infused into the coursework at the beginning of the 2019–2020 school year. Ten computers in the school's media center were equipped with Photoshop software. Students worked in the media center up to twice weekly to learn the basics of Photoshop. The academic biology unit under analysis in this study was "the role of selection in populations." The learning targets for this unit was that populations experience environmental limits to their growth and exhibit heritable variation in traits. Traits that improve an individual's chances of survival and reproduction become more common in the population, leading the population to be better adapted to its environment (Miller & Levine, 2002).

We began the unit's work as a whole group (Figure 1) by reviewing criteria for natural selection (including genetic variation, overproduction, struggle for existence, descent with modification, and adaptation) by showing a variety of examples related to our students' daily lives, such as horses, dogs, and turtles. Next, students chose the animal whose evolution they wanted to illustrate in a graphic story. Students searched online for information (in English or Spanish) on the history of natural selection for their chosen animal.

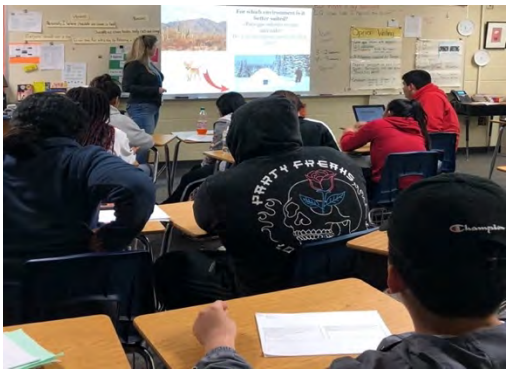

Figure 1
Class introduction to the role of selection in populations, 2019

Next, the students generated and wrote (in English, Spanish, or both) general descriptions of the evolution of their chosen animal on six panels that teachers created (Table 1). The students then drew all images for their six panels to tell the evolution story of their chosen animal. Students ultimately decided to use background images for their stories based on their animal's environment. After students finished their drawings, they added their written texts to include all the relevant information about their chosen animal.

Table 1
Six-panel graphic story based on the natural selection criteria

Panel	Graphic story based on the natural selection criteria
Panel 1	I am a/ an _____, and I want to tell my evolutionary story. My history goes back to the _____ period approximately _____ years ago. (location...if possible)
Panel 2	Genetic Variations such as _____ and _____ exist for my species and me.
Panel 3	Not all my offspring will grow up to adulthood. Often the offspring of our species die from _____ and _____.
Panel 4	I have many struggles for my existence. An example of this competition is _____.
Panel 5	I am well-suited for my natural environment based upon my heritable traits such as _____ and _____.
Panel 6	Closing the story.

Data Analysis

In Fall 2019, we began to collect data while implementing ten sessions of arts integration activities. The data for the current study were, primarily, the student-generated graphic stories of the evolution of their chosen animals. However, data for this study also included transcripts of the audio/video recordings of students participating in the Photoshop arts integration activities (both teaching and using Photoshop) and the researcher's field notes recorded throughout the study. The analyses of graphic stories are the primary focus of this study.

We deployed a version of hypothesis coding (Saldana, 2016) when analyzing the students' graphic stories. In hypothesis coding, a predetermined list of codes is used in the analysis of data. The codes themselves are generated from theories, predictions, or other means that anticipate "what will be found in the data before they have been collected or analyzed" (Saldana, 2016, p. 171). In our study, the codes were developed during the classroom discussion on animal evolution and on students' daily lives. The items identified during discussions as making up "evolution" in six panels (see Table 1) and students' daily lives comprised our predetermined list of codes. Each student's graphic story was analyzed for how well it included the "hypothesized" elements of evolution based on the natural selection criteria and students' daily lives that were worked out in advance. Hypothesis coding is ideal for this type of focused and narrowly defined project and because it seeks to "confirm or disconfirm" (Saldana, 2016, p. 171) the constructed definition of evolution and students' daily lives through an analysis of student-generated graphic stories.

RESULTS

Figure 2 depicts the assignment artwork created by Mateo (All students' names are pseudonyms). Mateo chose turtles because he had had a pet turtle in the country where he was born and raised. To do this project, Mateo did online research on the evolution of turtles through natural selection online. He first drew all his elements with Photoshop. For example, to show "overproduction," he drew a baby turtle; to show "struggle for existence," he drew a snake as turtles' enemy. After he finished his drawing, he added information he found through online resources and created his own story, choosing a comic font because he believed that "my turtle was so funny."

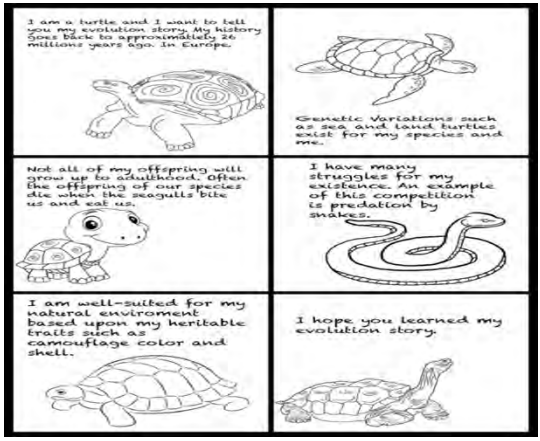

Figure 2
Mateo's design, The Evolution of the Turtles (graphic story designed with Photoshop,) 2019

Alex's graphic story is shown in Figure 3. Alex chose the evolution of the elephant. He also drew all elements of his graphic panels with Photoshop and found significant connections between the story of elephant evolution and his own life. For example, for illustrating "struggle for existence," Alex drew an alligator next to the lake as an enemy for elephants where they go and drink water. Alex also applied different backgrounds for his graphic stories' panels. According to Alex, "all the nature that I used for my background panels reminds me of the beauty of my country where I was born and raised." He also used capital words for the text in the panels texts to demonstrate the power of the elephant.

Figure 3
Alex's design, The Evolution of the Elephants (graphic story designed with Photoshop), 2019.

Santiago created the graphic story in Figure 4 about the whale. Santiago illustrated a sad baby whale to show "overproduction," and by adding text, intended to explain how some of the whales' offspring die from changes in ocean temperature and food availability. He used one background for all his panels because "whales can travel everywhere without any borders." Figure 5 shows Sara's illustration of dogs' evolutionary history. She wanted to create this story because she loves dogs and used to have dogs in her home country. Sara illustrated various breeds of dogs in the "genetic variation" panel. In the "struggle for existence" panel, Sara explained how she lost one of her dogs because of genetic defects. Sara also used one background for all the panels, saying that it "presents the beauty of nature in my city."

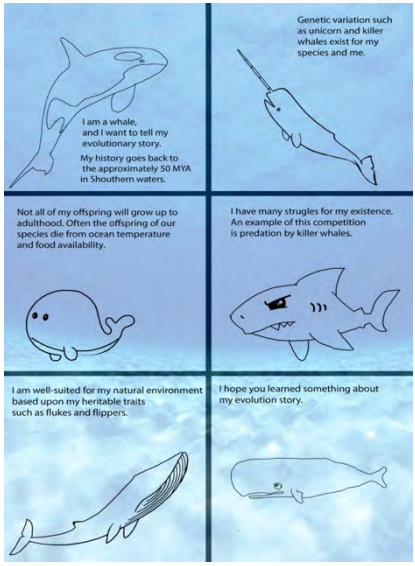

Figure 4 (left)
Santiago's design, The Evolution of the Whales, (graphic story designed with Photoshop), 2019.

Figure 5 (right)
Sara's design, The Evolution of the Dogs, (graphic story designed with Photoshop), 2019.

DISCUSSION

This study aimed to address how CSP and arts integration can be utilized to support the learning of ten students who speak English as their second language. To implement CSP in our study, instead of matching classroom practices to home cultures, we deliberately drew from contrasting worldviews, in that students and

teachers worked together to create knowledge about the role of natural selection in a population.

Creating graphic stories with Photoshop was an innovate learning opportunity that challenged and inspired students while supporting their individual goals and aspirations. Using this software gave our bi/multilingual students new skills and allowed them to be bold, expressive, and novel in their project presentation. However, access to computers is not necessary to conduct a similar project: the graphic stories can be created by hand with paper and pencil or any other art materials.

Students for whom English is a new language can often feel marginalized in U.S. schools because of cultural differences and the difficulty of language acquisition. Integrating arts activities into communication skills classes can also provide extra resources for future teachers who want to position bi/multilingual youth as significant active partners in the curriculum design. Making a graphic story gave students a stronger voice and greater competence, while also making the information required to meet academic standards more relevant to the students. It helped increase our students' confidence, as they were able to explain their biology unit to their friends and others by visually showing the graphic stories of their chosen animals. Increased confidence often unlocks profound potential in students who are reluctant learners, are shy, or have a language barrier (Brown 2019; Harman & Varga-Dobai, 2012; Park & Simpson, 2019). In fact, one student who was on the verge of quitting school stayed just to engage in and complete this project. She is on track to graduate in the spring of 2021 and has identified graphic design as a career she would like to pursue.

CONCLUSIONS

Culturally Sustaining Pedagogy (CSP) reframes how we teach bi/multilingual learners (Paris, 2012). CSP provided the foundation for integrating arts into a biology lesson. Students learned to draw on their experience and understanding to answer fundamental questions in biology in ways that made the information more relevant to them. The outcome of our work shows that integrating arts, primarily when related to students' lived experience and culture, can increase bi/multilingual student achievement, learning, interest, engagement, and skills in the science fields. Students can use the knowledge gained through the arts to deepen their understanding in other courses. Finally, allowing students to be creative increases their motivation and interest, leading to better test scores.

REFERENCES

Aghasafari, S. (2019). [Review of the book Art as a way of talking for emergent bilingual youth: a foundation for literacy in prek-12 schools, by B.R. Berriz, A.C. Wager & V.M. Poey]. *Visual Inquiry: Learning & Teaching Art, 8*(1), 91-93. Retrieved from doi: 10.1386/vi.8.1.91_5.

Arís, N., & Orcos, L. (2019). Educational robotics in the stage of secondary education: Empirical study on motivation and STEM skills. *Education Sciences, 9*(2), 73. https://doi.org/10.3390/educsci9020073

Arts Education Partnership. (2002). *Teaching Partnerships: A report of a national forum on partnerships improving teaching of the arts.* https://www.aep-arts.org/wp-content/uploads/Teaching-Partnerships_National-Forum-Report-on-Partnerships-Improving-Teaching-on-the-Arts.pdf

Baker, P.B., & Digiovanni, L.W. (2005). Narratives on culturally relevant pedagogy: Personal responses to the standardized curriculum. *Current Issues in Education, 8*. Retrieved from https://cie.asu.edu/ojs/index.php/cieatasu/article/view/1611.

Berriz, B. R., Wager, A. C., and Poey, V. M. (2019). *Art as a way of talking for emergent bilingual youth: A foundation for literacy in K-12 schools.* Routledge.

Bequette, J. W., & Bequette, M. B. (2012). A place for art and design education in the STEM conversation. *Art Education*, *65*(2), 40–47.

Brown, S. (2019). Constructing Stories Using Language and Digital Art: Voices of Multilingual Learners. In Berriz, B. R., Wager, A. C., & Poey, V. M. (Eds.), *Art as a way of talking for emergent bilingual youth: A foundation for literacy in K-12 schools.* Routledge.

Bruce, D. (2009). Writing with visual images: Examining the video composition processes of high school students. *Research in the Teaching of English, 43*(4), 426–450.

Burnaford, H. J. (2007). *Arts integration frameworks, research and practice.* Arts Education Partnership.

Cahnmann-Taylor, M., & Sanders-Bustle, L. (29 July 2019). Art-informed pedagogies in the preparation of teachers in the United States. *Oxford research encyclopedia of education.* Retrieved 5 Aug 2019 from https://oxfordre.com/education/view/10.1093/acrefore/9780190264093.001.0001/acrefore-9780190264093-e-376.

Chandler-Olcott, K., & Mahar, D. (2003). 'Tech-savviness' meets multiliteracies: Exploring adolescent girls' technology-mediated literacy practices. *Reading Research Quarterly, 38*(3), 356–385.

Chapell, S., & Cahnmann-Taylor, M. (2013). No child left with crayons: The imperative of arts-based education and research with language 'minority' and other minoritized communities. *Review of Research in Education, 37*(1), 243–68.

Creswell, J. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Pearson.

Creswell, J. (2013). *Qualitative inquiry and research design* (3rd ed.). Sage.

Dreeszen, C., Aprill, A., & Deasy, R. (1999). *Learning partnerships: Improving learning in schools with arts partners in the community.* Arts Education Partnership.

Duggan, T. J. (2007). Ways of knowing: Exploring artistic representation of concepts. *Gifted Child Today, 30*(4), 56–64.

Erwin, E.H. (2017). Full STEAM ahead in physical education. *Journal of Physical Education, Recreation & Dance, 88*(1), 3–4. DOI: 10.1080/07303084.2016.1249759

Fang, Z., Schleppegrell, M. J., Moore, J., Stone, C. A., Silliman, E. R., Ehren, B. J., & Wallach, G. P. (2014). The linguistic challenges of learning across academic disciplines. In C. A. Stone, E. R. Silliman, B. J. Ehren, & G. P. Wallach (Eds.), *Handbook of language and literacy: Development and disorders* (pp. 302–322). Guilford Press.

Gay, G. (2000). *Culturally responsive teaching theory, research, and practice.* Teachers College Record.

Glass, D., & Wilson, C. (2016). The art and science of looking: Collaboratively learning our way to improved STEAM integration. *Art Education*, *69*(6), 8–14.

Hadinugrahaningsih, T., Rahmawati, Y., & Ridwan, A. (2017). Developing 21st century skills in chemistry classrooms: Opportunities and challenges of STEAM integration. *AIP Conference Proceedings, 1868*(1), 1–8.

Harman, R., & Varga-Dobai, K. (2012). Critical performative pedagogy: Emergent bilingual learners challenge local immigration issues. *International Journal of Multicultural Education*, *14*(2), 1–17.

Heitin, L. (2015, April 2). When did science education become STEM? http://blogs.edweek.org/edweek/curriculum/2015/04/when_did_science_education_ become_STEM.html

Hetland, L., Winner, E., Veenema, S., & Sheridan, K.M. (2007). *Studio thinking: The real benefits of visual arts education*. Teachers College Press.

Hunter-Doniger, T., Howard, C., Harris, R., & Hall, C. (2018). STEAM through Culturally Relevant Teaching and storytelling. *Art Education, 71*(1), 46–51.

Jewitt, C. (2008). Multimodality and literacy in school classrooms. *Review of Research in Education, 32*(1), 241–267.

Kant, J. M., Burckhard, S. R., & Meyers, R. T. (2018). Engaging high school girls in Native American culturally responsive STEAM enrichment activities. *Journal of STEM Education: Innovations & Research, 18*(5), 15–25. Retrieved from http://search.ebscohost.com.proxyremote.galib.uga.edu/

Kress, G. (2000). Multimodality. In B. Cope and M. Kalantzis (Eds.), *Multiliteracies: Literacy learning and the design of social futures* (pp. 182–202). Routledge.

Kress, G. (2003). *Literacy in the new media age.* Psychology Press.

Ladson-Billings, G. (1995a). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice*, *34*(3), 159–165.

Ladson-Billings, G. (1995b). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*, 465–491.

Lawrence, S. A., McNeal, K., & Yildiz, M. N. (2009). Summer program helps adolescents merge technology, popular culture, reading, and writing for academic purposes.

Journal of Adolescent & Adult Literacy, 52(6), 483–494.
Leysath, M., & Bronowski, C. (2016). An adventure in full art integration. *Art Education, 69*(6), 28–34.
Marshall, J. (2010). Five ways to integrate: Using strategies from contemporary art. *Art Education*, *63*(3), 13–19.
Marshall, J. (2014). Transdisciplinary and art integration: Toward a new understanding of art-based learning across the curriculum. *National art education association studies in art education: A journal of issues and research*, *55*(2), 104–127.
Marshall, J. (2017). SLANT professional development in science and arts integration. In G. Diaz and M. Barry (Eds.), *Preparing educators for arts integration: Placing creativity at the center of learning* (pp. 139–147). Teachers College Press.
Martínez, R. A. (2018). Beyond the 'English learner' label: Recognizing the richness of bi/multi-lingual children's linguistic repertoires. *The Reading Teacher*, *71*, 515–522. doi:10.1002/trtr.1679
Metcalf, S. (2004). Art and physics. *Art Education*, *57*(1), 25–32.
Miller, K. R., & Levine, J. S. (2002). *Biology.* Prentice Hall.
National Academies of Sciences, Engineering, and Medicine. (2016). Barriers and opportunities for 2-year and 4-year STEM degrees: Systemic change to support students' diverse pathways. DOI: 10.17226/21739.
National Center for Education Statistics. (2016). *Racial/ethnic enrollment in public schools.* Retrieved from http://nces.ed.gov/programs/coe/indicator_cge.asp
NGSS Lead States. (2013). *Next Generation Science Standards: For States, by States*. The National Academies.
Nixon, A. S. (2009). Mediating social thought through digital storytelling. *Pedagogies: An International Journal, 4*, 63–76.
Paris, D. (2012). Culturally sustaining pedagogy: A needed change in stance, terminology, and practice. *Educational Researcher*, *41*(3), 93–97.
Paris, D., & Alim, H. S. (Eds.). (2017). *Culturally sustaining pedagogies: Teaching and learning for justice in a changing world*. Teachers College Press.
Park, J., & Simpson, L. (2019). Youth Voices from In and Out of the Classroom: Emergent Bilingual Learners, Graphic Novels, and Critical Multiliteracies. In Berriz, B. R., Wager, A. C., & Poey, V. M. (Eds.), *Art as a way of talking for emergent bilingual youth: A foundation for literacy in K-12 schools.* Routledge.
Patterson, J. (2015). Employing mindfulness via art in education. *International Journal of Education Through Art, 11*(2), 185–192.
Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking Skills and Creativity*, *31*, 31–43.
Puzio, K., Newcomer, S., Pratt, K., McNeely, K., Jacobs, M., & Hooker, S. (2017). Creative failures in culturally sustaining pedagogy. *Language Arts*, *94*, 223–233.
Remer, J. (1996). *Beyond enrichment: Building effective arts partnerships with schools and your community*. CA Books.
Saldana, J. (2016). *The coding manual for qualitative researchers* (3rd ed.) Sage.

Schramm, S. L. (2000). Genetic robots: An integrated art and biology curriculum. *Art Education*, *53*(3), 40–45.
Silverstein, L. B., & Layne, S. (2010). *What is arts integration?* The Kennedy Center for the Performing Arts.
Stokrocki, M. (Ed.) (2005). *Interdisciplinary art education: Building bridges to connect disciplines and cultures*. National Art Education Association.
U.S. Department of Education [USDOE]. (2015). *Reauthorization of the Elementary and Secondary Education Act*. https://www2.ed.gov/about/overview/budget/budget15/ justifications/a-eseaoverview.pdf
Wiggins, G., & McTighe, J. (2005). *Understanding by design*. Association for Supervision and Curriculum Development.
Yin, R. (2014). *Case Study Research: Design and Methods* (5th ed.). Sage.

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