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Interdisciplinary Learning Partnerships Between TK–2 Students and Scientists for Environmental Civic Learning

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Two former kindergarten teachers dreamed of helping fellow teachers foster the spirit of exploration for young learners in TK–2. After being awarded an education grant from the National Geographic Society, we were able to make this vision, which we call "Explorer Imprint," come to life. Using the anchoring curricular theme of water, during the 2021–2022 school year, twelve educators from the United States and Canada were provided with curricular kits containing tools used by established scientists as mentors, trade books, picture books, and age-appropriate tools (stuffed animals, art supplies, scientific inquiry tools) to support cross-curricular exploration inspired by the scientists. The findings from "Explorer Imprint" have resulted in a three-step interdisciplinary learning framework for partnerships between TK–2 students and scientists that is rooted in the NCSS curricular themes ❽ **SCIENCE, TECHNOLOGY, AND SOCIETY** and ❸ **PEOPLE, PLACES, AND ENVIRONMENTS.** In this article, we outline and describe this framework so that it can be replicated in other classrooms. We also showcase a selection of standards-aligned interdisciplinary learning activities from participating teachers and highlight resources to help practicing educators bring the "Explorer Imprint" vision into their classrooms to prepare the next generation of environmental change agents.

Young Children as Environmental Change Agents

What does it mean to teach environmental issues to young children? A curriculum featuring environmental topics "will be most successful when it starts in fifth or sixth grade and focuses on local problems where children can make a real difference."[1] However, this fails to consider students in kindergarten through fourth grade whose studies of social studies, English language arts, and science often explicitly include environmental issues in standards, curricula, or both. Young children, particularly in TK–2 (ages 3–8), are perfectly primed and fully capable of learning about complex, interdisciplinary issues and are prepared to take action on such issues to make a difference in their world.[2]

Integrating high-quality civics and social studies education and student-centered learning into school curricula contributes significantly to fostering these capacities in young children. The National Council for the Social Studies (NCSS) maintains that the main goal of social studies education is the promotion of civic competence: "to help young people make informed and reasoned decisions for the public good as citizens of a culturally diverse, democratic society in an interdependent world."[3] Teaching ecological citizenship and teaching about environmental issues are essential to high-quality social studies education for young learners.

Teaching Environmental Issues in Social Studies

"Citizenship education in the form of social studies ought to prioritize teaching and learning about environmental issues as part of civic education, just as it includes political, economic, and social issues."[4] Social studies also brings an interdisciplinary perspective to global issues that can reinvigorate civic engagement. The goal of Educating for Sustainability (EfS) is to broaden capacity for personal action at the individual and community level with the following outcomes:

- Recognition and understanding of the importance of the interconnectedness of these systems.
- And, respect for diversity for "points of view" and interpretations of complex issues from cross-multicultural (racial, religious, ethnic), regional and intergenerational perspectives.[5]

- A deep understanding of complex social, economic, and environmental systems.

We maintain that the NCSS curricular themes **❽ SCIENCE, TECHNOLOGY, AND SOCIETY** and **❾ PEOPLE, PLACES, AND ENVIRONMENTS** are most impactful for teaching environmental issues in social studies when collaborative learning partnerships are created between young children and real scientific experts. These mentor-based learning partnerships situate young children as having knowledge and contributions despite their young age.

Collaborative Learning Partnerships

Adults and children collaboratively working together can make a powerful impact in the world. Educational researchers Esteban Díaz & Bárbara Flores stipulate that teachers often take on the role of sociocultural mediator in addition to their traditional academic teaching roles.[6] To be effective sociocultural mediators, teachers—especially those with students of color or other historically marginalized students—should be aware that students bring a wealth of experiences and personal, cultural, and community knowledge with them into the classroom. As a result, teaching and learning are viewed as a mutual and collaborative endeavor between teacher and students, in which the teacher views the students as capable of creating, rather than only passively receiving, knowledge. This is parallel to scholar Paulo Freire's premise of collaborative co-construction of knowledge, which has implications for mentorships between students and scientists, as young students take action to address environmental issues of water inspired by the work of real scientists.[7]

Collaborative Partnerships Between Young Learners and Scientists: A Framework

Teaching and learning about global environmental issues, in partnership with scientists, have been conducted in kindergarten classrooms.[8] From this work, some best practices for integrating a scientist and their work into a classroom with young learners emerged:

- Young learners need something tangible to associate with the scientist, like a stuffed animal.
- Young learners need artifacts and tactile experiences to understand the scientist's work.
- Young learners need scientists who are friendly, approachable, and outgoing.
- Young learners make sense of the world through experiential learning and play-based learning experiences.

For "Explorer Imprint," we aimed to create a curricular framework based on the NCSS curricular themes **❽ SCIENCE, TECHNOLOGY, AND SOCIETY** and **❾ PEOPLE, PLACES, AND ENVIRONMENTS** for young learners in TK–2. To accomplish this, scientists who study water and have received grants from the National Geographic Society to support their work, also known as "National Geographic Explorers," were selected as mentors. As former kindergarten teachers, we recognize the practicality of having thematic units for teachers, which allows for more cross-curricular and project-based learning possibilities. Thematic concepts also allow for possibilities of collaborating with grade-level and school colleagues around a common learning goal, such as arts integration or experiences of students sharing their learning with similar-aged peers and adults. The world's water sources are precious resources, and according to the United Nations Secretary-General, Antonio Guterres, "Our bodies, our cities and our industries, our agriculture and our ecosystems all depend on it. Water is a human right. Nobody should be denied access."[9]

To be effective sociocultural mediators, teachers—especially those with students of color or other historically marginalized students—should be aware that students bring a wealth of experiences and personal, cultural, and community knowledge with them into the classroom.

The conservation and preservation of the world's freshwater and saltwater systems are integral to creating a sustainable world. We selected National Geographic Explorers who have dedicated their careers to the protection and conservation of the world's water systems and their creatures: Ocean with Dr. Jonatha Giddens, Freshwater with Andrés Ruzo, Freshwater with Dr. Dalal Hanna, and Aquaculture with Erina Molina and Dr. Joe Cutler. Within each unit, educators guided their young learners through three steps:

Step 1: Meet the scientist and learn about their story. Meet the scientist virtually through media or by looking at their website, build a relationship with the scientist through literature, see what the scientist's mission is, and represent the mission with a stuffed animal that is the mascot and guide for the three steps.

Step 2: Join the mission. After young learners have background knowledge of the scientist and their mission, they will mimic the scientist's work

by using age-appropriate tools. Students will collect data and use the tools in a similar way as the scientist.

Step 3: Extend the mission and take civic action. Once young learners build the skill set of the scientist in step two, students will synthesize that skill into their own mission to take civic action. It can expand on what the scientist is already doing, or the young learners can take on a new mission inspired by a scientist mentor and the needs of their community, focusing on what the student is passionate about.

Below is a step-by-step example, inspired by the work of Dr. Jonatha Giddens.

Join Dr. Jonatha Giddens' Mission of Ocean Exploration and Creativity

For teacher accessibility and usability, we created interdisciplinary curricular kits that can be applicable across different standards. Some key elements in each kit for age-level buy-in include a stuffed animal mascot, trade books and picture books to build background knowledge, and artifacts or scientific tools for skill building. The stuffed animal supports a non-profit cause, and each picture book is carefully selected for the TK–2 grade band and was approved by the scientist. Teachers who were matched with Dr. Giddens were provided with the following in a curricular kit, which prepared their students to engage with the pedagogical steps below:

- Octopus stuffed animal from Wild Republic
- Trade books about the ocean: *Down, Down, Down: A Journey to the Bottom of the Sea* by Steve Jenkins and *National Geographic Readers: In the Ocean*
- Set of oil pastels
- Trade book written by and about Dr. Jonatha Giddens' mentor, Dr. Robert Ballard, *Finding the Titanic*

Step 1: Meet the Scientist

In Step 1, young learners build a relationship with the scientist and learn about their mission. In this step, first graders from Canada learned about Dr. Giddens by watching a short video about her work from her website, jonathagiddens.com. The video shows how Dr. Giddens blends art and science in her professional work. Students listened to a read-aloud book, *Down, Down, Down: A Journey to the Bottom of the Sea* by Steve Jenkins to learn about how Dr. Giddens uses drop cameras to study the deep ocean. This connects with the NCSS curricular theme **SCIENCE, TECHNOLOGY, AND SOCIETY**. Students were inspired by how Dr. Giddens used art as a form of communication in her work, and they used oil

Figure 1. First graders are inspired by Dr. Giddens' use of oil pastels and watercolors in her work and are using paints to represent ideas from the text.

pastels and watercolors to draw important details from the text (see Figure 1). The students also asked and answered questions about the text and about Dr. Giddens' work, such as "What does she see from her drop cam? Is the octopus her friend?" This connects to the Inquiry Arc of the C3 Framework, particularly Dimension 1: Developing Questions and Planning Inquiries. TK–2 students participating in these activities would also fulfill grade-level content standards (See Table 1).[10]

Step 2: Join the Mission

In Step 1, students learned that Dr. Giddens not only collects data on ocean life but that she also uses art to communicate her data to audiences. In Step 2, students will mimic the scientist's work by using age-appropriate tools that support imitation, such as a magnifying glass, binoculars, or in Dr. Giddens' case, art integration. Step 2 correlates with Dimension 2: Applying Disciplinary Concepts and Tools. In this step, first graders engaged with the NCSS theme **CIVIC IDEALS AND PRACTICES** as they participated in STEAM projects to design solutions for ocean pollution. Students used a combination of recyclable materials, K'Nex (math manipulatives), and art supplies (see Figure 2). These activities also fulfilled some of the National Core Art Standards for Visual Arts and Creating (see Table 1). For example, students used recyclable materials to make schools of fish, learn about why fish swim together in a group, and counted the number of fish in the school. Students used paper plates and K'Nex to make jellyfish and learned about why tentacles are important for jellyfish. Students also used sticky notes

and popsicle sticks to determine the length of a lion's mane jellyfish and to measure if the students were bigger or smaller as a comparison.

Step 3: Extend the Mission and Take Civic Action

Once learners build the skill set of the established scientist in Step 2, learners will synthesize that skill into their own mission to take civic action in Step 3. This mission can expand on what the scientist is already doing, or they can take on a new mission inspired by the scientist's work. This correlates with Dimension 4 of the C3 Framework, Communicating Conclusions and Taking Informed Action. In this step, students expand on the scientist's work and bring it into their local community. For example, inspired by Dr. Jonatha Giddens' work, students could use art to communicate about issues of local concern about the ocean or water and design a solution. First-grade students made a stop-motion video with their stuffed octopus to show how things go into the ocean through drainage systems. The video discussed how pathways to the ocean resulted in local pollution becoming a larger global issue. Another first-grade class used oil pastels, like Dr. Giddens, to learn about animals and the functions

Table 1. Standards Alignment
Join Dr. Jonatha Giddens' Mission of Ocean Exploration and Creativity

Step 1: Meet the scientist and learn about their story.
SCIENCE, TECHNOLOGY, AND SOCIETY **Dimension 1:** Developing Questions and Planning Inquiries **Common Core ELA Standards:** CCSS.ELA-LITERACY.SL.K.1: Participate in collaborative conversations with diverse partners about *kindergarten topics and texts* with peers and adults in small and larger groups. CCSS.ELA-LITERACY.SL.1.1.A: Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion). CCSS.ELA-LITERAC Y.SL.2.1.C: Ask for clarification and further explanation as needed about the topics and texts under discussion.
Step 2: Join the mission.
CIVIC IDEALS AND PRACTICES **Dimension 2:** Applying Disciplinary Concepts and Tools **National Core Art Standards for Visual Arts—Creating:** Anchor Standard 1: Generate and conceptualize artistic ideas and work. Enduring Understanding: Creativity and innovative thinking are essential life skills that can be developed. Essential Question(s): What conditions, attitudes, and behaviors support creativity and innovative thinking? What factors prevent or encourage people to take creative risks? How does collaboration expand the creative process? VA:Cr1.1.Ka. Engage in exploration and imaginative play with materials. VA:Cr1.1.1a. Engage collaboratively in exploration and imaginative play with materials. VA:Cr1.1.2a. Brainstorm collaboratively multiple approaches to an art or design problem.
Step 3: Extend the mission and take civic action.
CIVIC IDEALS AND PRACTICES **Dimension 4:** Communicating Conclusions and Taking Informed Action **National Core Art Standards for Visual Arts—Connecting:** Anchor Standard 10: Synthesize and relate knowledge and personal experiences to make art. Enduring Understanding: Through art-making, people make meaning by investigating and developing awareness of perceptions, knowledge, and experiences. Essential Question(s): How does engaging in creating art enrich people's lives? How does making art attune people to their surroundings? How do people contribute to awareness and understanding of their lives and the lives of their communities through art-making? VA:Cn10.1.Ka. Create art that tells a story about a life experience. VA:Cn10.1.1a. Identify times, places, and reasons by which students make art outside of school. VA:Cn10.1.2a. Create works of art about events in home, school, or community life.

Figure 2. First graders are participating in STEAM projects to design solutions for ocean pollution. A combination of recyclable materials, K'Nex (math manipulatives), and art supplies are used.

Figure 3. Following Andrés Ruzo's advice on scientific note-taking, a first grader is writing the date, labeling images/sketches, and writing ideas down so that others can interpret them to make discoveries.

of their body parts. This step is essential to help students engage in projects that are relevant to their lives and interests.

Join Andrés Ruzo in Geothermal Adventures

Some teachers were matched with Andrés Ruzo, a geothermal scientist. Andrés' work shows us that water has many states of matter, and liquids and gas are particularly relevant to his work. Teachers were provided with the following in a curricular kit, which prepared their students to engage with the following pedagogical steps:

- Anteater stuffed animal from Wild Republic
- Trade books: *Volcanoes* by National Geographic Reader and *What is the World Made Of? All About Solids, Liquids, and Gases* by Kathleen Weidner Zoehfeld
- Picture book about Andrés Ruzo's mentor**,** Jacques Cousteau: *Manfish: A Story of Jacques Cousteau* by Jennifer Berne
- Lego City Volcano Explorers 60120 Volcano Starter Set Building Kit, inspired by Andrés Ruzo
- Field notebooks

Step 1: Meet the Scientist

In Step 1, first graders in Virginia enjoyed learning about how scientists like Andrés Ruzo must engage in note-taking for their research by using field notebooks. This connects with the NCSS curricular theme **SCIENCE, TECHNOLOGY, AND SOCIETY**. The participating teacher stated,

> Taking on the skill of note-taking was a huge success and took off in a class the teacher was coaching. Students spent time drawing observations and labeling in their preferred language and noticing details in their world, inspired by Andrés' tips on proper note-taking. Some specific tips that Andrés had about note-taking were that he was able to find the Boiling River because of the very detailed notes that someone else took. As a result, in his notes, and as a recommendation to future scientists, he recommends using the date, labeling images/sketches, and clearly writing ideas down so that others can interpret them and possibly find awesome discoveries! (See Figure 3)

This supports the connections between the ELA/Literacy Common Core Standards and the C3 Framework and their role in social studies inquiry (see Table 2).

Step 2: Join the Mission

In Step 1, students learned about how geothermal scientist, Andrés Ruzo, uses note-taking in his work. Students also learned about Andrés Ruzo's work in the Amazon and how he learned about his fieldwork site, the Boiling River, from his grandparents in Peru. Students learned about his work through listening to the read-aloud provided in the kit, *What is the World Made Of? All About Solids, Liquids, and Gases* by Kathleen Weidner Zoehfeld. Students also listened to selected clips of Andrés' TED Talk, "The Boiling River of the Amazon." Following the read-aloud and TED Talk, students asked and answered questions about Andrés' work, such as "Is the Boiling River dangerous?" "Why is it boiling?" "If it's supposed to be a secret place, why is Andrés telling

us about it?" "What lives in the Boiling River?" This shows connections to the Inquiry Arc of NCSS's C3 Framework, in particular, Developing Questions and Planning Inquiries, Dimension 1 (see Table 2).

Step 3: Extend the Mission and Take Civic Action

After building the skills of the established scientist in Step 2, learners will synthesize that skill into their own mission for Step 3. The teacher stated,

> The students were most inspired by learning that Andrés had grandparents who had amazing stories. The students began to wonder what stories their grandparents had from when they were young and created a project to learn about where their grandparents grew up and their cultural stories from their own childhoods. Many learners called their grandparents during this portion of their learning to ask about their lives and their stories, and in turn, learned more about their own family history.

This connects with the NCSS curricular themes ❶ **CULTURE,** ❾ **GLOBAL CONNECTIONS,** and ❸ **PEOPLE, PLACES, AND ENVIRONMENTS**. This also fulfills Dimension 3, Evaluating Sources and Using Evidence, and Dimension 4, Communicating Conclusions and Taking Informed Action (see Table 2). The students' desire to learn about the natural world and the environment through history, storytelling, and oral history

Table 2. **Standards Alignment**
Join Andrés Ruzo in Geothermal Adventures

Step 1: Meet the scientist and learn about their story.
❽ **SCIENCE, TECHNOLOGY, AND SOCIETY** **Dimension 4:** English Language Arts/Literacy Common Core Connections **Common Core ELA Standards:** CCSS.ELA-LITERACY.W.K.1: Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or name of the book they are writing about and state an opinion or preference about the topic or book. CCSS.ELA-LITERACY.L.1.1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. CCSS.ELA-LITERACY.L.2.1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
Step 2: Join the mission.
❺ **INDIVIDUALS, GROUPS, AND INSTITUTIONS** **Dimension 1:** Developing Questions and Planning Inquiries **Common Core Literacy Standards:** CCSS.ELA-LITERACY. SL.K.1: Participate in collaborative conversations with diverse partners about *kindergarten topics and texts* with peers and adults in small and larger groups. CCSS.ELA-LITERACY. SL.1.1.A: Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion). CCSS.ELA-LITERACY. SL.2.1.C: Ask for clarification and further explanation as needed about the topics and texts under discussion.
Step 3: Extend the mission and take civic action.
❶ **CULTURE,** ❾ **GLOBAL CONNECTIONS,** and ❸ **PEOPLE, PLACES, AND ENVIRONMENTS** **Dimension 3:** Evaluating Sources and Using Evidence **Dimension 4:** Communicating Conclusions and Taking Informed Action **Common Core Speaking and Listening Standards:** CCSS.ELA-LITERACY. SL.K.1: Participate in collaborative conversations with diverse partners about *kindergarten topics and texts* with peers and adults in small and larger groups. CCSS.ELA-LITERACY. SL.K.1.A: Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion). CCSS.ELA-LITERACY. SL.K.1.B: Continue a conversation through multiple exchanges. CCSS.ELA-LITERACY.SL.1.1: Participate in collaborative conversations with diverse partners about *grade 1 topics and texts* with peers and adults in small and larger groups. CCSS.ELA-LITERACY.SL.1.1.A: Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion). CCSS.ELA-LITERACY.SL.1.1.B: Build on others' talk in conversations by responding to the comments of others through multiple exchanges. CCSS.ELA-LITERACY.SL.1.1.C: Ask questions to clear up any confusion about the topics and texts under discussion. CCSS.ELA-LITERACY.SL.2.3: Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information, or deepen understanding of a topic or issue.

also has implications for their understanding of community cultural wealth and the collaborative co-construction of knowledge,[11] which can be intergenerational.

Professional Development Impact and Opportunity

We aimed to create a curricular program that translated the essence of exploration and discovery for young learners in TK–2nd grade. To accomplish this, established scientists whose work involves water were selected as mentors for the young learners to gain inspiration. Teachers were also given pre- and post-surveys which asked about their thoughts on using exploration in their pedagogy and bringing the work of scientists into the classroom. Teachers were asked to provide a testimonial on the impact they saw as a result of their participation in "Explorer Imprint" for the 2021–2022 school year. A first-grade teacher from Canada stated,

> The learners were engaged and hooked on the topics we discussed. When they heard personal titbits of information about the explorers like their hobbies or how many languages they spoke, they were able to identify and share their own experiences. They loved the book choice(s), and we started every lesson with a book reading for 15 minutes followed by taking notes and discussing and we then did a follow-up activity. They looked forward to every class and their outlook on what exploration is and who an explorer is…does broaden.

Participating teachers also shared insights about how authentic and collaborative learning experiences for educators can increase their own agency, motivation, exploration, and discovery. A second-grade teacher from Kansas stated,

> This professional development opportunity was very meaningful to my practice as an educator. Since working with young learners within a STEAM position was completely new to me during the past school year, the Explorer Imprint program provided ideas on the process of exploration which helped propel my programming during part of the year. Being able to connect with other educators and explorers provided a lot of inspiration and motivation during this otherwise challenging pandemic school year. I am very grateful to have had this opportunity to be part of the Explorer Imprint program.

This demonstrates that collaborative learning partnerships and actionable curricula to address environmental themes are beneficial for practicing educators as well as young students.

Conclusion

In times of climate emergency, extreme heat, and ongoing natural disasters, learning about the environment has never been more timely or more urgent. Education for Sustainability (EfS) is essential for helping our youngest learners develop the interdisciplinary skills needed to take civic action for a more sustainable and just future. This can be achieved through interdisciplinary learning using art and literacy and through using NCSS curricular themes and the C3 Framework. In teaching ecological citizenship to young learners, intergenerational partnerships with real experts like scientists are key. Young students taking action to address the global environmental issue of water inspired by the work of real scientists is the education we need.

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