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Riverology: Promoting Stewardship of Rivers Through Youth Participation in Science and Art

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RIVEROLOGY: PROMOTING STEWARDSHIP OF RIVERS THROUGH YOUTH PARTICIPATION IN SCIENCE AND ART

by

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ABSTRACT

RIVEROLOGY: PROMOTING STEWARDSHIP OF RIVERS THROUGH YOUTH PARTICIPATION IN SCIENCE AND ART

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This project focuses on mentoring children to help reduce marine debris in their local river by implementing one of ten lessons from an inquiry-based *Riverology* curriculum to empower youth voice, increase geo-literacy, and spatial thinking. Eighteen participants aged seven and eight, piloted *Riverology Lesson 2: What Do I Know or Imagine about the Elizabeth River?* that includes six steps: inquire, visualize, draw, share, act, and reflect. The children were asked to make drawings before and after viewing an Elizabeth River Story Map presentation (Dunbar, 2021a). The drawings were then compared to see if the participants included marine debris, stewardship solutions, and a mental map of the river with branches. This study addresses four questions 1.) Why should we teach youth about rivers? 2.) How can creating art and stories serve as a communication tool for students to share their ideas? 3.) How can visualization activities be utilized to connect youth to their local rivers? 4.) What barriers do students face on their journey to act and participate in the public sphere? Scholars, such as Jürgen Habermas (1974), Sibel Ozsoy and Berat Ahi (2014), Tom Cockburn (2019), Lynda Barry (2019), and Millie Kerr (2016) have advocated for a citizen democracy fueled by youth participation in the arts. Some of these efforts have been applied to environmental conservation, but no such inquiry-based effort has been undertaken to address the stewardship of the Elizabeth River in Virginia. The scale of the marine debris issue sometimes creates the impression that local actions are futile, but research shows people using their own expertise and knowledge as stewards is a driver

for change (N. Bennett, et al., 2017). To foster river stewards these young participants completed *Riverology Lesson 2* and although none of their pre- drawings included marine debris or stewardship actions, 83% of the post- drawings did. In addition, only 11% drew a mental map of the river in their pre- drawings, but 44% did after viewing maps and images. An unexpected finding showed none of the drawings included people and this may relate to youth empowerment issues, the inquiry question wording, or COVID-19 isolation.

Key words*:* visualization, inquiry, river education, mental maps, marine debris, stewardship

This thesis is dedicated to my parents. My father, a first-generation college graduate, for inspiring all the generations that follow to pursue their dreams and let their skills and talents shine and lead the way. My mother taught me how to tell stories and encouraged me to do it my way – combining my love for art, science, and children.

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CHAPTER I

INTRODUCTION

BACKGROUND

The Elizabeth River in southeast Virginia became one of the most polluted rivers of the Chesapeake Bay for many reasons including a growing population, industrial accidents, loss of wetlands and runoff. The brackish six-mile tidal estuary runs through the cities of Norfolk, Portsmouth, Chesapeake, and Virginia Beach. The watershed population is about 500,000 and includes the world's largest military naval base, the oldest working shipyard and a world-class port (Census.gov). In 1983, the Environmental Protection Agency indicated that the Elizabeth River was one of the most highly polluted bodies of water in the entire Chesapeake Bay watershed (Norfolk.gov). In addition, the Elizabeth River is experiencing one of the nation's highest sea level rises – second to New Orleans according to the World Resources Institute (Tompkins, 2014).

"Unfortunately, the Elizabeth River is also experiencing frequent high tide flooding even on days without rain," explains Derek Loftis, Assistant Research Scientist at the Virginia Institute of Marine Science (Loftis, 2020). With low-lying areas and proximity to coastal waterways, flooding continues to impact the river's watershed communities. Nicole LeBoeuf, acting director of NOAA's National Ocean Service says the flooding is only going to increase in the future (NOAA.gov). With flooding comes runoff, litter, and debris that travels from the land and through storm drains that empty into the river. Debris and litter even impact students enroute to school as they slush through the muddy debris flood waters that cover streets,

parking lots and sidewalks. When the tide recedes, rubbish goes with it especially if the shoreline is void of dense wetlands and native grasses. Floating debris can affect water quality, wildlife that lives in and around the river, and can also hinder navigable waterways. Margaret Mulholland, a biological oceanographer at Old Dominion University says the types of debris she has seen flowing into the Elizabeth River includes tossed away food containers, oil cans, dirty diapers and pet waste (Mulholland, 2019).

Throughout the COVID-19 pandemic, the litter and debris appeared to be increasing in the Elizabeth River's watershed, especially single-used items. Time Magazine's March 2021 issue stated, "Norfolk, Virginia is seeing historic highs in litter and illegal dumping" (Semuels, 2021). Virginia's 2016 Marine Debris Reduction Plan states, "While methods of determining abundance of marine debris vary, there is agreement that up to seventy-five percent is made up of plastics" (K. Register, and L. McKay, 2016).

Plastic pollution is a global problem that we are all facing, and it is found in our waterways, the food we eat, and the water we drink. Oceanographer Laurent Lebreton estimates that between 1.15 and 2.41 million tons of plastic flow from the global riverine system into the ocean each year (Lebreton, 2017). All ages need to take action and find a solution to the plastic pollution and it begins with the choices we make as consumers and producers.

One way children can help is not influencing families to buy so many plastic toys since studies show 90% of all toys world-wide are made of plastic materials (Green Chemistry Sustainability, 2020). Various toys are often seen in volunteer river cleanups such as balls, frisbees, whistles, balloons, and Legos. These toys could have a new role helping youth to make a connection to how their choices could impact the health of a river. One way would be through

inquiry lessons that ask how these toys ended up in the river, how far they traveled and what can youth do to help. Rivers carry trash over long distances and connect nearly all the land surfaces with the oceans “making rivers a battleground in the fight against sea pollution,” explains Christian Schmidt, a hydrogeologist at the Helmholtz Center for Environmental Research in Leipzig, Germany (Patel, 2018). Inquiry-based learning provides youth an opportunity to explore ideas while making sense of the world around them (Gholam, 2019).

There are about 125,000 students of all ages in the Elizabeth River watershed with 7,500 in the second grade that are aged seven and eight (Census.gov). Schools in the Elizabeth River watershed do not teach about the river, and it is not included in the curriculum standards (Virginia Department of Education). Youth need to have the tools, confidence, and knowledge as they problem solve and inherit this challenged river. Even the youngest children can contribute meaningfully to their communities with their ideas, but they need to be invited to the table (Fredericks, 2001).

It could be empowering to youth to be a part of helping adults with a polluted river and it may lead to a deeper self-belief in their ability to create change (Kirby, 2003). University of Colorado’s professor Louise Chawla’s research shows adults mentoring youth to value nature can result in a generation of lifelong environmental stewards (Chawla, 1999). Mentors such as teachers, scientists, grandparents, and community leaders, can share stories of ways they connected to the river and in turn foster the next generation of river stewards.

PROJECT OVERVIEW

Riverology aims to inform children about the state of the Elizabeth River and to promote good stewardship in our area's youth. As such, I have chosen to engage with students through the medium of drawing and storytelling. To better understand what eighteen students, aged seven to eight, are imagining about their river, a draw and explain method provides them an opportunity to communicate their thoughts and ideas. Drawing can help children make their ideas visible (Brooks, 2009), and storytelling in science can be a tool to promote inquiry skills that are essential to prepare children to deal with new challenges (Gatt, 2012). This *Riverology* study includes implementing an inquiry activity to learn how the participants envision their home river, whether they perceive the river to be challenged with marine debris and if they understand stewardship actions that could help. The International Review Board approved this *Riverology* study with youth and the required Human and Social Behavioral training was completed prior to implementing (See Appendix B and C).

An inquiry based Riverology curriculum was developed (See Appendix A) and includes ten lessons (Dunbar, 2021b). Although educators are encouraged to focus on their local river, the *Riverology* curriculum showcases the Elizabeth River in Virginia as a teaching model. Eighteen second grade participants piloted one of the ten lessons – *Lesson Two: What Do You Know About Your River?* (See Table 1).

Lesson 1	What Does Earth Look Like?
Lesson 2	**What Do You Know About Your River?**
Lesson 3	What's a Flying Bird's View of Your River?
Lesson 4	What is on the Bottom of the River?
Lesson 5	How Does Pollution Get in the River?
Lesson 6	What Does the River Look Like After a Storm?
Lesson 7	What Does Sea Level Rise Look Like?
Lesson 8	What Do River Plants and Animals Look Like?
Lesson 9	What Does a River Superhero Look Like and Do?
Lesson 10	What Will Your River Look Like in the Future?

Table 1. *Riverology* Curriculum

Each *Riverology* lesson includes six steps that begin with an inquiry question about an aspect of their local river. This inquiry method allows students to seek information by questioning. Students begin by closing their eyes and pondering possible answers to the inquiry question. Next, students draw what they are thinking and share with the educator. The educator then presents a story that complements the inquiry question followed by students once again closing their eyes and drawing and explaining their thoughts. The final step asks students to reflect on what they learned and celebrate their achievements. Teachers analyze the pre- and post- drawings utilizing a template of coded criteria to see what the students learned.

This *Riverology* six-step method is modeled after National Geographic's Geo-Inquiry Activity, but with modifications that include elementary students, a river and marine debris focus, visualization, story maps, pre- and post- drawings and river stewardship (See Table 2). The students' pre- and post- drawings are analyzed to measure the percentage that a.) depict a polluted river with marine debris, b.) include stewardship actions that would improve marine debris challenges and c.) include a mental map of the river with branches like a tree.

	RIVEROLOGY PROCESS	GEO-INQUIRY PROCESS
Inquire	Inquiry question provided.	Students develop an inquiry question together with the teacher's guidance.
Visualize	Students are quiet, close their eyes, think, ponder, and imagine.	Students utilize maps to organize their thoughts, stories, and data.
Create	Teachers gather information for stories. Students draw a picture about what they are thinking.	Students conduct research and choose visuals such as storyboards to share their information.
Share	Teachers present a story and information about rivers and students share their drawings.	Students have dialogues with their teachers and teams and discuss how to present their ideas.
Act	Stewardship actions are recommended that relate to creating a healthy river.	Students share their ideas with an audience through web, posters, and events.
Reflect	Students are given time to think about what they learned and will do to help their home river and then celebrate their achievements with a menu of options.	This phase is called an Assessment and students answer prompts and then discuss as a class what they liked and would change.

Table 2. Comparing the *Riverology* Inquiry Process to National Geographic's Geo-Inquiry Process

Story maps are web applications and communication tools that educators, scientists, and others can create stories with interactive maps, text, tables, images and more. Story maps can be an effective teaching tool in science education, a way to consolidate a lot of information and content in an organized format and has the potential to enrich spatial thinking and geo-literacy (Cope, 2018). ESRI provides a free tool for users to create story maps by combining ArcGIS and their chosen content and then publish privately, public with accessibility by laptops, tablets, and smartphones. Internet is necessary to view the story maps. Although story maps are not required in all the *Riverology* lessons, an Elizabeth River Story Map was created and utilized in this study and instructions on how to create them are included in the curriculum. Below are the user-friendly steps one takes to create a story map (See Table 3).

1	In the web browser the researcher typed "story maps for ArcGIS".
2	Clicked "New Story from Scratch".
3	Created a title, *The Elizabeth River*.
4	Clicked the "add" button to attach images, maps, videos, and a slide show.
5	Once completed, the Elizabeth River Story Map was published for the public to access.
6	The Story Map included a brief overview of the Elizabeth River to enrich the students' post-drawings, complement the inquiry question and included information that helped to answer the following questions: • What percentage of drawings depicted a polluted river with marine debris versus a river without marine debris? • What percentage of drawings included key features representing solutions or stewardship that would improve marine debris and litter challenges? • What percentage of drawings included a mental map of the river looking like a tree limb with branches?

Table 3. Steps to Create an ArcGIS Story Map

CHAPTER II

LITERATURE REVIEW

TEACHING YOUTH ABOUT LOCAL RIVERS WITH INQUIRY

As seen in Fig. 1, children may think of Earth as a blue marble since bodies of water play an important role in their mental models of their environment (Vins, 2014). Rivers connect most of the global land surface to the marine environment (Schmidt, 2017) and are the circulatory system of the continents, drain nearly seventy-five percent of the earth's land surface, and provide excellent habitat and food for many of earth's organisms (AmericanRivers.org).

When children learn about river science it cannot be just about understanding concepts, it must also be about exploration and having the opportunity to inquire, participate, and develop a sense of belonging in the scientific practice (C. Caiman, and Britt Jakobson, 2019). Wynne

Fig. 1. NASA Blue Marble: "Behold one of the more stunningly detailed images of the Earth yet created. This Blue Marble Earth montage, created from photographs taken by the VIIRS instrument on board the Suomi NPP satellite, shows many stunning details of our home planet." https://images.nasa.gov/details-PIA18033.

Harlen of the University of Bristol notes it is important for children to deepen their understanding through inquiry science activities and educators need to understand how to incorporate inquiry into their classroom lessons (Harlen, 2013). Inquiry also provides an opportunity for students to take more responsibility for their learning and consider alternative explanations (National Science Education Standards). Students shift from "why not" to a more engaged "how can" attitude.

HOW CREATING ART AND STORIES SERVE AS COMMUNICATION TOOLS FOR CHILDREN TO SHARE THEIR IDEAS

There are limited research studies on children communicating their knowledge about rivers with drawings (Dove; Galani; Mackintosh; Vins). Although, the power of drawing for children is that it closely represents thought, and it can help make their ideas visible (Brooks, 2009). A drawing can also express something in the same way that spoken or written words can (E. Alerby, 2015). Also drawings are an alternative form of expression for children who have difficulty expressing their ideas (Galani, 2014).

Children's drawing intentions should be viewed as purposeful where "drawing thus becomes a constructive process of thinking in action" (Cox, 2005). Drawing can play a role in visualizing science concepts and recording ideas and most young children have a strong desire to draw since it can be permanent and tangible (Brooks, 2009). Unfortunately, educators underuse drawing as an option for students to learn science (Dove, 1999). When children draw a river, research shows they often draw a section of a river or a view as if standing on the river bank (Mackintosh, 2005). Children also often color rivers blue. Lynda Barry, winner of the MacArthur

Genius award and professor of creativity at University of Wisconsin-Madison, argues that we draw before we are taught, and stories appear on their own when kids draw (Alam, 2019).

Drawings could play a role in empowering children to share their ideas about how to take care of rivers in the public sphere. Cockburn argues, “The language and practices of politics and policy making tend to be alienating for children, and children’s preferred ways of expressing opinions need to be better understood” (Cockburn, 2009). Ozsoy and Ahi argue that children are more at ease when drawing (Ozsoy, 2014). Although, students should understand that it doesn’t matter how skilled they are at drawing and that the drawings are about expressing their thoughts (Einarsdottir, 2009). There can be misinterpretation of drawings’ meanings as the child may have had difficulties with the art medium tools or something could be misinterpreted.

Recently, scholars have been recommending for children to explain their drawings to researchers to clarify meaning (C. Caiman, and Britt Jakobson; Rennie; Strommen; Vins). Drawings are susceptible to uncertainties and might require some explanation to clarify (Gershon, 2001). Drawings combined with a child explaining their drawing will enrich the understanding (E. Alerby, 2015). Several scholars included a combination of drawing and explaining such as (Dove, 1999) with learning concepts of a river basin, understanding of wetlands (Hulland, 1994), understanding the human body (Reiss, 2002) and understanding the digestive system (Teixera, 2000). Educators may consider adopting a draw-share-listen to better understand young children’s meaning-making in science (C. Caiman, 2015).

It is not the drawing, but the process of analyzing and interpreting the meaning of the drawing that is significant (E. Alerby, 2015). The meaning of images resides in the ways researchers and educators interpret those images (Einarsdottir, 2009). The analysis process is attempting to get an overall understanding of the meaning expressed in the drawings as the same

methods of formal analysis of images applied to complex iconographic programs of more formal art can also be applied to the drawings of children. The process could consist of a.) looking for similarities and differences such as in pre- and post- drawings b.) noting patterns c.) creating a mind-map to document the interpretations and d.) making inferences about the meaning or themes responsible for the patterns identified in the drawings (E. Alerby, U. Bergmark, 2012).

When children are asked to share their drawings, they are telling a story. Phillips explains, "The term storytelling has many interpretations, and one is an oral art where a teller performs a story with a live audience and both teller and listener experience the story together in the same place at the same time. Listeners can connect with the characters and accompany the teller on the journey of experience that may result in new insight and understandings" (Phillips, 2010). German philosopher Walter Benjamin claims that storytelling offers a fuller understanding versus just providing information and the listener learns about themselves and the world with an experience he terms, "Erfahrung or Erscheinung" and it is up to the listener to interpret the content of the story (Benjamin, 1936). The work of Egan is also notable in supporting storytelling as a meaningful teaching methodology (Kiernan Egan, 1986; 1997, 2005).

Teachers could create and utilize web-based story maps to communicate science concepts, but scholars argue utilizing them in the classroom is limited (J. M. Blaut; Strachan). Esri offers a free platform to easily create engaging story maps with a user-friendly application for beginners (Strachan, 2014). Story maps could help tell the story of how a river has changed over time and include a bird's eye view perspective to help children learn a new perspective when thinking about rivers. Researchers argue, "The ability to call up precise and rich images is a unique feature of our minds and is clearly connected with the development of the imagination"

(Judson, 2017). Children begin to understand maps at a very young age. James Morris Blaut, an American professor of geography at the University of Illinois at Chicago, showed “preschool children have substantial mapping abilities and adding maps may help youth develop spatial reasoning” (J. M. Blaut, 1997). In addition, Blaut and researchers argue that “nearly all humans, in all cultures, acquire the ability to read and use map-like models in very early childhood, and that this ability is a fundamental part of human ecological adaptation that is comparable in many ways to tool use” (J. M. Blaut, David Stea, Christopher Spencer and Mark Blades, 2021).

Scientists should learn the art of storytelling too, although many scientists believe it is better to just keep to the facts. Focus for this study includes scientists sharing their research with understandable narratives and serving as mentors to youth (Kieran Egan; ElShafie; Hulland; Kroeber; Padian). Science communication must be a search for meaning and one of the most effective ways to do this is through storytelling (ElShafie, 2018). There are good reasons for scientists to tell their stories more effectively, but they may need to “unlearn” how they were taught and instead learn to develop an engaging story about their research (Padian, 2018). Science educators could help scientists improve their storytelling (Negrete, 2004). Stories are easier to comprehend, and audiences find them more engaging than traditional scientific communication (Bruner, 1986).

Scientists that focus on animal protection are harnessing the art of storytelling as conservation storytellers. Millie Kerr, a conservation storyteller, argues that if you want to connect with the public to inspire action – you need to be able to tell a good story (Kerr, 2016). Storytelling could empower youth to share their ideas with adult leaders. Today’s storytelling should be interactive and memorable to be told again and engage others (Kroeber, 1992). The

bonus would be if scientists share their passion for their research, they could be getting others excited about science too (Padian, 2018).

If children, teachers, and scientists came together and created a strong story about rivers challenged with marine debris – it could be powerful, but adults need to be willing to include children. Cockburn argues that children should be active citizens with adults, and citizenship should not be gained by age (Cockburn, 1998). There needs to be a shift to create public spaces where children are valued and respected (Phillips, 2010). Habermas argues, "Communicative action requires an achieved agreement" and in a platform where opinions are shared, 'goal oriented' with 'reasoned argument' and each takes a position, offers explanation for their view and there is 'feedback'(Habermas, 1991). Hence, communities need to work together.

HOW VISUALIZATION ACTIVITIES CONNECT YOUTH TO A RIVER

Envision students being invited to attend a town hall meeting where they share their ideas about how to tackle the litter in the river while referring to their drawings. For the drawings to be effective – the children need time to think and visualize their ideas. Although there is a growing body of research on digital visualization media, there are no studies on education strategies that include the *Riverology* method of children being instructed to close their eyes, visualize an idea, and then draw, share, act and reflect. Visualization is key to creativity as it helps keep the mind focused on fleshing out ideas or solving problems such as environmental challenges. Visualization is also central to learning and should play an important role in science education (Gilbert, 2005). Children should be provided opportunities to visualize and then make it visible to others by speaking their mind or putting it on paper (Chen, 2004). Today, children

are often spending more time with electronic devices where their attention is on imaginary worlds. Educators need to incorporate cognitive and inquiry-based tools that may engage the imagination (Fettes, 2013).

To have the confidence and skills to share their ideas with a river community, children should be encouraged to learn about the river system and be provided time to be curious and ask questions (Mackintosh, 2005). Taking time to think is important and allows students to synthesize an experience, make observations, create ideas, or act (Hartsfield, 2013). Children need opportunities to think and reflect to give expression to their thoughts with the help of drawings and words (E. Alerby, 2000). In cognitive problem-based learning, students process knowledge content in a deeper, mindful manner and learn valuable thinking skills as they are encouraged to go beyond information (Chen, 2004). They need time to imagine a river community that is actively engaged and committed to their river's health.

Imagination is a powerful cognitive tool for learning (Judson, 2017). Children's imagination and creativity is a vital part of their meaning-making (C. Caiman, and Britt Jakobson, 2019). Root-Bernstein argued that imagination is missing in current science curricula and alongside scientific inquiry and learning facts, imagination should be taken seriously (Root-Bernstein, 1996). *Riverology* engages children in activities that combine visual art and science to learn about their home rivers. The art and science disciplines are related, as imagination, emotions, inquiry, and analysis are part of both (Root-Bernstein, 1996). Imagination also has a great significance when children create and recommend solutions to a problem (C. Caiman, and Iann Lundegard, 2018).

A river does not belong to adults only – it is everyone's responsibility to be good stewards of earth's natural resources. In the United States, almost half of rivers and streams are considered to be in poor biological condition and need all ages to help (Chellaney, 2020). Although children use public spaces, they are often marginalized in local planning debates (Lauwers, 2005). According to German philosopher Habermas, one needs to be engaged in social life and the political process and come together to discuss common interests (Habermas, 1974). "Children want to be active citizens involved in community projects," explains Louise Phillips, professional storyteller, and early childhood teacher at the University of Queensland. Cultures and societies need to reinforce that children should be engaged in decision making about environmental issues now and not just prepared for future participation (Phillips, 2010).

Policy decisions made today could have long lifespans. A transformative shift can be cultivated for adults to include youth in problem solving river issues and it is essential for public spaces to adapt to a variety of different voices at different levels. Sociologist Tom Cockburn argues, students have a powerful voice that can be heartfelt, although children engaged in the public sphere are limited and constrained by not permitting their voice (Cockburn, 2007). Historians Lauwers and Vanderstede research shows when a community establishes a network of people in favor of the interests of children in public spaces and equipped to translate their ideas – opportunities for children's participation becomes achievable (Lauwers, 2005).

Habermas's conception of the public sphere and communicative action starts from the understanding of deliberative processes where there is an exchange of information, discussions about public matters, and opportunities for consensus (Habermas, 1984). In *Structural*

Transformation of the Public Sphere, Habermas refers to the public sphere as *Öffentlichkeit* and spends most of his book describing a specific communicative phenomenon that developed in the late 18th century (Habermas, 1991). Habermas is particularly interested in the rise of coffee houses and public squares where debate about the best laws and policies could take place through letters, books, and debate. We often deny youth the right to sit around the table to help make decisions and assume the adult citizens are doing the hard work.

It is important for youth to participate in the public sphere, so that they have opportunities to share their point of view. As a democratic society, if we support inclusion and equal respect for all persons, then adults should mentor youth to be engaged citizens and provide spaces for youth to participate. Arguments of exclusion include maturity and cognitive ability – but this could also be said of adults (Martin, 2018). Children and adults need to work together to make changes. Cockburn adds challenges for youth to participate in policy changes include, "a lack of interest by policy makers and children's opinions are often dismissed as trivial or unimportant" (Cockburn, 2009).

Phillips argues the most important work of early childhood education for sustainability is negotiating barriers to children's social, political, and civic access and that educators need to work with children to navigate these barriers (Phillips, 2014). This is not about giving youth a long list of chores or burdening them with the river's problems, but instead taking time to cultivate empathy, question, and act. Cockburn argues, "Children do not feel that their opinions are being listened to" (Cockburn, 2005). Habermas indicates the capacity for a child to communicate is fully possible by the ages of five to nine when the process of acquiring language is complete (Habermas, 1990). Adults can help 'translate' children 'voices' (Lauwers, 2005).

Educators and scientists should serve as mentors and help students share their opinions and present their ideas to decision makers and one way could be children sharing their ideas through drawings. Young children easily communicate their ideas through drawing and art can stimulate learning and thought about society and our interconnected lives and about the social sphere as a whole (S. Bennett, 2018). Cockburn suggests that if children are invited to participate "such initiatives must be broadly welcomed, as any opportunity that potentially opens up the possibility of dialogue with young citizens can only be beneficial" (Cockburn, 2009). Art can also probe our emotions and possibly create a rich conversation about the future.

CHAPTER III

METHODOLOGY

The goals of this research study was to begin to understand if an inquiry-based curriculum could be included in a traditional classroom to teach youth about their home river's challenges with marine debris and include visualization (taking time to think and imagine), draw, and share with stories. Four questions were addressed including 1.) Why should we teach youth about rivers? 2.) How can creating art and stories serve as a communication tool for second grade students to share their ideas? 3.) How can visualization activities be utilized to connect youth to their local rivers? 4.) What barriers do second grade students face on their journey to act and participate in the public sphere?

Four distinct methods were deployed in this study: literature review (See Chapter 2), archival research, marine debris sampling, and draw-and-explain analysis. Some challenges during this study included implementing it during the COVID-19 pandemic. Although an entire second grade participated from one school or 27% of the school's population, quantitative studies aim for a minimum of 100 participants. Some scholars recommend including 5-10% of a population, but also argue that "it depends" (Delice, 2018). This study represents 1.4% of the population of Portsmouth, Virginia's second grade public school population (Census.gov). It is unknown if the participants' choices were influenced by COVID-19 protocols of isolation, wearing masks, disconnection from community settings with large numbers of people, etc. Students' previous knowledge of the river was also not accessed. The teacher and parents were asked not to educate or influence the students with information about the Elizabeth River prior to the study, but whether that occurred or not is unknown.

HISTORICAL MAP ARCHIVAL EXPLORATION

An online archival investigation of Elizabeth River maps was implemented to include in the *Riverology* curriculum, as a teacher resource, and to create story maps. Also, students could compare maps over time as seen in fig. 2 below. Archival collections explored included the Library of Congress, the Mariners Museum (Newport News, VA), Slover Library (Norfolk, Virginia), Old Dominion University (Norfolk, Virginia), National Oceanic and Atmospheric Administration Chesapeake Bay Headquarters (Norfolk, Virginia), Corps of Engineers Front Street (Norfolk, Virginia), and Norfolk Naval Shipyard (Norfolk, Virginia).

Fig. 2. 1873 Map of Norfolk and Portsmouth, Virginia. Retrieved from the Library of Congress, https://www.loc.gov/item/75696645/.

MARINE DEBRIS SAMPLING

For students to see examples of marine debris found in the Elizabeth River during *Riverology Lesson 2* while sharing the Elizabeth River Story Map, debris was collected at five different sites in Norfolk, Virginia near Old Dominion University. Three of the sites are at Old Dominion University, Norfolk, Virginia where one of the sites has open water and is void of wetlands, another has a large storm drain outfall and one parallels a dog park. Two additional Norfolk sites included the Virginia Zoo entrance that has a dense natural wetland and Grandy Village Learning Center that has a restored wetland and is considered an epicenter of flooding.

DRAW AND EXPLAIN ANALYSIS

A comparative analysis similar to a quantitative approach used by Strommen (1995) was utilized to analyze thirty-six pre- and post- drawings and codes were calculated to render the findings (Strommen, 1995). This was combined with a qualitative pre- and post- method where students shared stories about their drawings and explained their thoughts to decrease misinterpretation (Galani, 2014). This diagnostic method is like using ‘draw and write’ used to understand children’s ideas, but for *Riverology*, the students are not asked to write a story, but instead orally explain (McWhirter, 2000). For this study, this draw and explain method was accomplished virtually

This *Riverology* project was approved by the Institutional Review Board for working with youth (See Appendix D). Christopher Academy’s Head Mistress, Mrs. Merriam Terry granted permission to perform the research with all the second-grade students. A signed letter

was presented to the researcher that included approval for the students' drawings to be utilized, analyzed, and measured (See Appendix E).

Christopher Academy Second Grade students learned about the Elizabeth River where it was geographically positioned, and how it changed over time. They viewed various maps, learned how the Elizabeth River is a living and working river, and that all ages can play a role as stewards. They learned how to share what they know about the Elizabeth River through drawings, how litter is impacting the water quality, wildlife, and habitat.

Located in Portsmouth, Virginia, Christopher Academy is a preschool through fifth grade, independent, nonsectarian school with accreditation by the Virginia Association of Independent Schools. The school's mission is they are committed to academic excellence by providing an enriching curriculum that cultivates a lifelong love of learning. Students are empowered to be independent thinkers and confident leaders prepared to succeed in a dynamic world. Second grade students are aged seven to eight years old, and the teacher ratio is 16:1.

All eighteen, second grade students from Christopher Academy in Portsmouth, Virginia participated in this research study. Participants included 28% girls and 72% boys (See Table 4). There was an equal distribution of aged seven students (50%) and aged eight students (50%).

	AGE		
GENDER	7 years old	8 years old	Total
Girl	4	1	5
Boy	5	8	13
Total	9	9	18

Table 4. Number of Children Distributed by Age and Gender

Although the Christopher Academy second grade students were attending school on-site, this *Riverology* research project was presented virtually on the 13th and 21st of April 2021 per requirements from the Institutional Review Board for working with youth during the COVID-19 pandemic. All the students were provided an opportunity to voluntarily participate, and assured no one would get mad, be disappointed or in any way pressure them to participate. The parents, legal guardians, and students were assured they could stop participating at any time. Information packets were distributed to all, and forms signed. The student names were not recorded, and drawings were securely stored.

RIVEROLOGY CURRICULUM AND SUPPLIES

A *Riverology* curriculum was developed and includes ten inquiry-based lessons to inspire river stewardship. The students piloted *Lesson 2: What Do You Know About Your River?* Each lesson follows a six-step process that asks students to inquire, visualize, draw, share, act and reflect. An inquiry question was created for each lesson along with a list of questions the lesson should help answer.

Prior to implementing the lesson with the students, supplies were assembled for the students to utilize during the virtual classroom presentation. The supplies were put in individual recycling bags and the classroom teacher made sure each student received them prior to the virtual lesson. Each student received the same supplies.

STUDENT SUPPLIES	
	a small mini globe with a 12-inch circumference
	a map of the Elizabeth River
	a satellite map made with Google Maps of their school (Christopher Academy, Portsmouth, VA), the Elizabeth River with branches, the river's cities and a compass rose
	a sheet of artist paper
	a brand-new box of assorted oil pastels
	a document with images of Elizabeth River animals and wetland grasses
	a recycled plastic bottle filled 1/3 with water and small polystyrene pellets that floated on the water's surface and a small 1-inch metal fish bead that sunk to the bottom
	a sandwich size ziploc bag with a chunk of polystyrene that students could manipulate to break apart the pellets that are seen floating in the water bottles they were given

Table 5: Student Supplies for *Riverology* Lesson Two

IMPLEMENTING *RIVEROLOGY* LESSON TWO

The students completed *Lesson 2* over two days with the pre- drawing completed on the first day and the post- drawing completed on the second day after viewing the Elizabeth River Story Map and engaging with hands-on activities.

DAY ONE

On 13 April 2021, I met virtually with all eighteen Christopher Academy students during their regularly scheduled science class from 1:45pm to 2:30pm. The goal of the first day was for the students to complete their pre- drawing and share with me what they were thinking when asked the inquiry question. The lesson stopped prior to viewing the Elizabeth River Story Map.

Step 1 Inquire: Students were asked, “What do you know about the Elizabeth River?”

Step 2 Visual: Students were then given a minute and asked to close their eyes and envision what they knew or imagined about the Elizabeth River. The students were not provided any prompts or descriptive suggestions.

Step 3 Draw: Students then completed a pre-drawing of what they were thinking or imagining about the Elizabeth River. Students drew their pre- drawing on one side of the paper. This was important to be able to compare the two drawings without the students writing their names on the paper. They were given fifteen minutes to complete the pre- drawing. The students were reminded that the activity was about using art to share what they were thinking, imagining, and envisioning and it was not about how well they could draw. Students were also told this activity was not for a grade.

Step 4 Share: After fifteen minutes, the students were asked to stop drawing and one at a time they shared and explained their drawings. Students were then asked to put their drawings in their recycled bag until the following week for the post-drawing activity.

DAY TWO

The goal of the second day, 21st April 2021, was for the students to complete their post-drawings after viewing the Elizabeth River Story Map, analyzing found marine debris items and engaging in hands-on activities. *Lesson 2* continued and started with Step 4: Share.

Step 4 Share: Students listened to a presentation while viewing the ArcGIS Elizabeth River Story Map and analyzed marine debris found in the Elizabeth River. Unique and commonly seen debris items were shown to the students and included single-used plastics, fishing line, food and drink containers, straws, and unique items such as a variety of balls of all sizes, sunglasses, and a fire extinguisher. Students also viewed maps and learned how the river changed over time to accommodate a growing population and working river. Students learned how marine debris can impact animals, habitat, and maritime vessels. With the plastic water bottle, students learned how some marine debris floats and some sinks to the bottom and observed things that are light and float and things that are dense sink. They learned the tiny ball shaped pieces of floating polystyrene are used in packaging of items and to keep food cold and hot. They observed a small metal fish bead that sank to the bottom and learned that it sank because it was dense, and that heavy debris can sink to the bottom of rivers. They discussed the lifespan of marine debris and how some break down into tiny, small pieces from weather, wear, tear, temperature, and

wave action. The students manipulated and broke the chunk of polystyrene that each received in a sealed sandwich bag. The students noticed it broke into small pellets or balls that float. The students discussed how animals may eat marine debris like the polystyrene and that it can be transferred through the food chain.

All the eighteen second grade students completed a post-drawing of the Elizabeth River answering the same inquiry question, "What Do You Know about Your River?" After fifteen minutes, the students were asked to stop drawing and one at a time they shared and explained their drawings. The drawings were collected by the Christopher Academy second grade teacher who also examined to make sure names were not written on any of the drawings. (See Table 6 to view the template used to analyze the drawings.)

Step 5 Act: Students learned and discussed stewardship actions that may help with the marine debris challenges the Elizabeth River is facing. This allowed the students to make additional comments and connections about what they drew and why. Stewardship actions included cleanups, reducing single-used plastics, restoring wetlands, planting trees, educational signage, trash receptacles, policies, and river appreciation.

Step 6 Reflect: The students were provided a few minutes to think about what they had learned and how they could continue to help protect and restore the Elizabeth River. They celebrated their achievements by removing the small metal fish in the plastic water bottle and attaching it to a string for a necklace. The drawings will be given to adult decision makers to encourage marine debris policies.

	Yes	No
Is the pre- drawing different from the post- drawing?		

PRE-DRAWING	Yes	No	POST DRAWING	Yes	No
In the drawing was the river depicted as polluted with marine debris?			In the drawing was the river depicted as polluted with marine debris?		
In the drawing were wildlife harmed due to pollution.			In the drawing were wildlife harmed due to pollution?		
In the drawing were stewardship actions or key items that help a river with marine debris included?			In the drawing were stewardship actions or key items that help a river with marine debris included?		
• Wetlands			• Wetlands		
• Trash cans			• Trash cans		
• Trees			• Trees		
• Messages or signs			• Messages or signs		
• Celebration			• Celebration		
• Recreation			• Recreation		
Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?			Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?		
Did the drawing include local landmarks (home, school, bridges, buses, maritime vessels, etc.)?			Did the drawing include local landmarks (home, school, bridges, buses, maritime vessels, etc.)?		

Table 6: *Riverology Lesson 2* Student Drawing Evaluation Form. This is used to evaluate the students' pre- and post- drawings.

CHAPTER IV

DATA COLLECTION

The data of this *Riverology* study was derived from a comparison of drawings produced by empirical material consisting of drawings produced by second grade students collected at Christopher Academy in Portsmouth, Virginia during ordinary school activities the 13th and 21st of April 2021. All the eighteen second grade students (five girls and thirteen boys) included in the study attended school in Portsmouth, Virginia that has a population of 95,000 and is located on the western side of the Elizabeth River.

A total of eighteen second grade students (100%) participated in the drawing study, and they were aged seven to eight years old, and each student completed a pre- and post- drawing totaling 36 drawings. Students were recruited through an informational packet which was sent home with them for review by their parents or legal guardians. Analyzing the drawings by age and gender was not a measurable criteria but could be included in future research. The data was calculated to note the percentage as a whole sample of eighteen participants and not individually.

The drawing activities began with the students closing their eyes and imagining what they knew about the Elizabeth River. Instead of putting their thoughts into words, they made a drawing depicting what came to their minds. The participants were told this was not for a grade and that it was not important how skilled they were at drawing. The participants were given fifteen minutes to complete their drawings and used oil pastels and artistic paper where one side was for the pre- and the other the post- drawing. Once complete, the Christopher Academy second grade teacher collected and examined the drawings to ensure there were no names.

The analysis of the drawings included evaluating the meaning of the children's thoughts and noting the differences between the pre- and post- drawings. Analyzing the youth drawings was challenging as the seven- and eight-year-old students' artistic abilities are not well-advanced where some of the drawings still depicted objects floating in space. A less formal approach was used in this study and the students were told their artist ability was not being evaluated, but instead they were to draw what they were thinking. Providing an opportunity for the students to explain their drawings was essential in understanding the meanings. An Evaluation Form was used to capture the students' explanations and analyze each drawing according to coded criteria (See Table 7).

Code	Brief Definition
Is the pre-drawing different from the post-drawing?	The two drawings are not identical.
In the drawing was the river depicted as polluted with marine debris?	Discolored water (brown, yellow, black, gray, orange) with geometric shaped objects that also were dark or discolored or objects clarified by student as representing pollution and/or marine debris
In the drawing were wildlife harmed due to pollution?	Do animals appear sad, upset, disfigured, trapped, missing body parts?
In the drawing were stewardship actions or key items that help a river with marine debris included?	Any number of stewardship items that depict an improvement or healthier looking river. Items could include litter cleanups, volunteers, wetland grasses restored and/or healthy, trees being planted or saplings, trash bins or receptacles, messages or signs that encourage not polluting or encourage stewardship, celebration, and appreciation of the river with joy being reflected (rainbows, smiles, boating, biking, walking, swimming, fishing)
Were wetlands depicted in the drawings?	Wetland grasses present, shoreline vegetation that was void in the pre- drawing, wetland restoration
Were trash cans depicted in the drawings?	Trash receptacles, buckets, containers, recycling bins
Were trees depicted in the drawings?	Increase in trees in the picture or new baby sapling trees being planted
Were signs with messages depicted in the drawings?	Symbols or words that may mean toxic, poison, do not pollute or recycle
Was a celebration depicted in the drawings?	Parties, smiling faces, rainbows, sunshine, bright colors
Was a form of recreation depicted in the drawings?	Walking, boating, biking, swimming, fishing
Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?	River has an aerial versus a land view, river has branches and has changed shape perspective
Did the drawing include local landmarks?	Homes, schools, bridges, maritime vessels, shipyards, cranes, railroads

Table 7. Definitions of Criteria Codes

CHAPTER V

RESULTS

Results showed an educator could integrate the *Riverology* curriculum into a traditional science class to inspire stewardship and provide youth an opportunity to share their ideas about marine debris in their home river through drawings and stories. Prior to sharing information about the river with a story map and artifacts, when the students were asked what they knew or imagined about the Elizabeth River, 100% drew a river free of marine debris. After learning about the Elizabeth River, 83% included marine debris and 17% drew a healthy river with animals, rainbows, and a vibrant urban city (See Fig. 3).

Fig. 3. Christopher Academy's Student Drawings 10, 11 and 12. The pre-drawings are on the top row and post-drawings on the bottom row. The pre-drawings show a river with animals and a void of marine debris. The post- drawing of image 10 shows a river that now has rainbows, wetlands, and wildflowers; image 11 shows animals harmed by marine debris; and image 12 shows an urban river with tall buildings, streets, wetlands, and trees.

Fig. 4. Christopher Academy's Student Drawings 7, 8 and 9. The pre-drawings are on the top row and post-drawings on the bottom row. Note the additional marine debris in the post-drawings along with wetlands and more trees. The children also depicted a mental map of the river with branches after viewing maps and images of the river.

Fig. 5. Christopher Academy's Student Drawings 4, 5 and 6. The pre-drawings are on the top row and post-drawings on the bottom row. Only image 6 included people in the pre-drawing. In the post- drawing the participant included animated "minions" as stewards.

Fig. 6. Christopher Academy's Student Drawings 1, 2 and 3**.** The pre-drawings are on the top row and post-drawings on the bottom row. Note the addition of wetlands in image 1 and image 2 post-drawings. Explanation is key as in image 3 pre-drawing where the student explained the black shape in the upper right corner is a ship, and the brown shading in the bottom left corner is pollution on the post-drawing.

Fig. 7. Christopher Academy's Student Drawings 13, 14 and 15. The pre-drawings are on the top row and post-drawings on the bottom row. Image 15 post-drawing depicts hope for a river that is challenged with marine debris.

See Table 8 and 9 for results after the students viewed the Elizabeth River Story Map that included maps, aerial images of the river and stewardship actions that would help create healthy shorelines that improve water quality and provide habitat for animals.

- 44% of the participant's post-drawings included a mental map of the river with branches
- 56% of the participants included more trees
- 83% more wetlands (the highest-ranking stewardship action)
- 67% depicted wildlife that had been harmed or exposed to marine debris
- 44% drew trash cans

The children often chose to use the color black, brown or red to depict marine debris as in the image 8 post-drawing (See Fig. 4). Further research could be included to analyze color choices and meaning. An unexpected finding was that although students viewed adults and children implementing stewardship actions in the Elizabeth River Story Map only one student in image 6 included people in the pre-drawing and 0% of the participants included people in the post-drawings (See Fig. 5). This requires further research, but possible reasons could be:

- The inquiry question may need rewording to include the people.
- Students may draw only based on their experiences and perceptions.
- The participants had spent a year living with the COVID-19 pandemic protocols of social distancing and isolation although their school continued in-session with an option for virtual instruction. All the second-grade students were receiving in-class instruction but being disconnected from community groups may need to be considered.
- One participant envisioned animated "minions" cleaning the river, not people or themselves. Children not feeling empowered to help should be considered.

An interesting development was one of the students may have drawn an “emotional response” after learning the Elizabeth River was polluted with marine debris. Image 17 shows an elaborate healthy river system in the pre-drawing, but a chaotic river in the post-drawing (See Fig. 8). This is one reason recommending the pre- and post- drawings be on the same sheet of paper is essential for noting changes and being able to compare. Psychologist and art therapist, Dr. Cathy Malchiodi, shares in her book *Understanding Children’s Drawings* that drawings have been undeniably recognized as one of the most important ways that children express themselves and has been repeatedly linked to the expression of emotions (Malchiodi, 1998).

Fig. 8**.** Christopher Academy’s Student Drawings 16, 17 and 18. The pre-drawings are on the top row and post-drawings on the bottom row. Image 17 pre-drawing and post-drawing may depict an emotional response.

Code	Brief Definition	Yes	No		
Is the pre-drawing different from the post-drawing?	The two drawings are not identical.	100%	0%		
		Pre-Yes	**Pre-No**	**Post Yes**	**Post No**
In the drawing was the river depicted as polluted with marine debris?	Discolored water (brown, yellow, black, gray, orange) with geometric shaped objects that also were dark or discolored or objects clarified by student as representing pollution and/or marine debris	0%	100%	83%	17%
In the drawing were wildlife harmed due to pollution?	Do animals appear sad, upset, disfigured, trapped, missing body parts	0%	100%	67%	33%
In the drawing were stewardship actions or key items that help a river with marine debris included?	Any number of stewardship items that depict an improvement or healthier looking river. Items could include litter cleanups, volunteers, wetland grasses restored and/or healthy, trees being planted or saplings, trash bins or receptacles, messages or signs that encourage not polluting or encourage stewardship, celebration, and appreciation of the river with joy being reflected (rainbows, smiles, boating, biking, walking, swimming, fishing)	0%	100%	89%	11%
Wetlands	Wetland grasses present, shoreline vegetation that was void in the pre- drawing, wetland restoration	50%	50%	83%	17%
Trash cans	Trash receptacles, buckets, containers, recycling bins	0%	100%	44%	56%
Trees	Increase in trees in the picture or new baby sapling trees being planted	61%	39%	56%	44%
Messages or signs	Symbols or words that may mean toxic, poison, do not pollute or recycle	0%	100%	22%	78%
Celebration	Parties, smiling faces, rainbows, sunshine, bright colors	6%	94%	11%	89%
Recreation	Walking, boating, biking, swimming, fishing	11%	89%	6%	94%
Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?	River has an aerial versus a postcard land view, river has branches and has changed shape perspective	11%	89%	44%	56%
Did the drawing include local landmarks?	Homes, schools, bridges, maritime vessels, shipyards, cranes, railroads	6%	94%	6%	89%

Table 8. Differences in Pre- and Post- Drawings

	Pre-Drawing	Post-Drawing
What percentage of drawings depicted a polluted river with marine debris versus a river without marine debris?	0%	83%
What percentage of drawings included key features representing solutions or stewardship that would improve marine debris and litter challenges?	0%	89%
What percentage of drawings included a mental map of the river looking like a tree limb with branches?	11%	44%
What percentage shows wildlife harmed due to pollution?	0%	67%
What percentage included landmarks	6%	6%
What percentage included humans in the drawing?	6%	0%
What percentage included wetlands?	50%	83%
What percentage included trash cans?	0%	44%
What percentage included messages and signs?	0%	22%
What percentage included a celebration?	6%	11%
What percentage included recreation?	11%	6%

Table 9. Summary of Findings in Pre- and Post- Drawings

CHAPTER VI

DISCUSSION

CHILDREN DRAWING A RIVER AND CHALLENGES

Previous research studies suggest that when children think or envision a river, it is often in a rural environment (Dove, 1999). The results of this study indicated when the children think or visualize the Elizabeth River, they do not think about the industry that surrounds it including shipyards, military bases, the coal pier, railroads, stacks of shipping containers and cranes. In addition, although the second-grade teacher in this study shared that she will include drawing more often in the classroom activities, research shows that educators often do not include it as an option for children to better understand science (Dove, 1999). Some educators might debate the use of drawing as a tool to document observations since many children use drawings to represent their thoughts and emotions (Fox, 2013). Although, Kaatz claims that young children are able to understand the differences between scientific and creative drawings (Kaatz, 2008).

I do see this *Riverology* inquiry-based curriculum as a way teachers might engage with students about river ecology and civic engagement. There was a drastic increase in the number of students who included toxic elements or pollution from the before drawings to the after drawings. Children could help find solutions to river pollution, but it may be more likely if they feel hopeful about the challenge. Hope is a motivational force that is important to help engage people in solving problems as well as increase understanding about an issue like marine debris (Li, 2017). By the age of seven to eight, children begin to demonstrate the ability to think ahead

with the realization that the future may be something to work towards – but they need hope (Hicks, 1995).

A major limitation in this study was not knowing if all the participants knew what a river was or whether they had visited a river. Simplified instruction that includes age-appropriate environmental terms should be included. For example, research shows that 9–11-year-old children would not understand the term 'river-basin' (Dove, 1999). When teaching children geography, it should not be all about memorization of words and places (Butt, 2011), but instead geography should be about the study of the home of people (Tuan, 1991). Follow up interview questions should be considered to better understand the participant's prior and learned knowledge about rivers. Understanding the importance and knowledge of place, culture, resources and natural environments is essential for interconnectedness with challenges such as marine debris that is a global issue (Golledge, 2002).

Although this study included the students explaining what they drew, there is a risk of missing additional interpretations with a drawing sample. Feedback from others should be included to avoid overgeneralization, misinterpretations, and additional findings. Analysis of drawings can be complex and including a well-thought-out goal and objective is essential (E. Alerby, U. Bergmark, 2012).

Although the participants' pre-drawings did not include marine debris in the Elizabeth River, it is unknown if they had prior knowledge that the Elizabeth River was polluted or if they had a personal experience with it. Perhaps their choice of envisioning the Elizabeth River without marine debris was age appropriate – envisioning a world free of responsibilities and problems (Kirby, 2003). One possibility could be that they have not been exposed to an adult mentoring them about river litter cleanups. Research shows adults mentoring youth about the

environment can result in lifelong stewards (Chawla, 1999). Participation with their parents in such activities provides children with the opportunity for observation, direct experience and parents' convey a message about the value of the river and taking ownership to protect it (Goodnow, 1988).

At the beginning of each *Riverology* lesson, students are asked to close their eyes and think, be quiet and imagine. Although in this study the students understood that experiencing silence was part of the lesson, there are often mixed messages to students between what the "being quiet" objective is – maintaining order or "thinking time" (E. Alerby, 2019). Silence should be considered valuable as a teaching strategy for providing space and time for students to think, ponder and wonder.

Due to the research taking place during COVID-19 pandemic, the students were not able to engage in a classroom stewardship project until the end of the school year. The students plan to do litter cleanups and the second-grade teacher may utilize NOAA's *Turning the Tide on Trash*, an interdisciplinary guide on marine debris for grades 1-12 to enhance the stewardship action projects. Marine debris is an issue that will require continued attention for generations to come (K. Register, 2012).

Interviewing the students virtually was challenging, but did work. Providing additional time for the students to share their drawings and ideas would be ideal. Storytelling in the classroom has the capacity to capture children's attention and imagination, which suggests it might be a powerful teaching strategy in science (Banister, 2001).

The goal is for the drawings to be delivered to local decision makers and policy leaders. Due to COVID-19, these people are still working from home with a goal to return during summer 2021. The drawings will be delivered upon their return.

CHAPTER VII

CONCLUSION

The results from this study provide useful information for inquiry-based curriculum design for youth to learn about rivers that includes visualization, drawing, sharing, acting and reflection. This study has been based on an analysis of pre- and post- drawings produced by eighteen, second grade students aged seven to eight years old and about a river polluted with marine debris. Researchers argue that children's drawings are a useful data collection tool as they create an environment for children to freely express their ideas and this data supports that argument (Ozsoy, 2014). It was shown that children envisioned the Elizabeth River was healthy with animals, trees, and clean water prior to learning about the river's challenges with marine debris and the river being known as one of the most polluted rivers of the Chesapeake Bay. After learning how the river had changed over time with a story map and marine debris transformed into teaching content, 83% of the children's post-drawings depicted a polluted Elizabeth River with 17% choosing to draw a river of hope with rainbows, sunshine, and wildflowers. These results confirm with other research (Dove, 1999).

Although this was a small sample, the six-step, inquiry-based *Riverology* lesson did achieve the expected results of successfully being incorporated into a traditional science class to teach youth about their home river that is challenged with marine debris. This is important because if traditional classroom teachers do not endorse informal resources – they will not include them. In addition, the activity provided opportunities for the students to close their eyes, visualize, draw their thoughts, and voice their ideas through stories.

This study brings into question whether schools are providing activities where the children's thoughts are given attention and how to create a curriculum that includes inquiry, visualizing, drawing, sharing, action, and reflection. The *Riverology* curriculum has not been published or piloted with all age levels and implementing the ten lessons with a variety of ages is recommended along with testing the activities in-person and virtually.

Children could have difficulties understanding environmental challenges and educators should seek ways to empower youth to play a role with age-appropriate stewardship. Cockburn argues that youth experience more confidence in making shared decisions with adults and that projects exist that touch young people's lives already and embed a decision-making process (Cockburn, 1998). Phillips argues that educators can work with children on their ideas to act and that one way to talk about sustainability is through story. Cockburn argues, "If children's citizenship is to become meaningful it must firstly be located in a radically pluralistic public arena and respect for differences must be maintained" (Cockburn, 2005). Scientists could serve as mentors to inspire, inform, and engage youth to share their ideas with policy makers with their drawings about Elizabeth River marine debris. Youth have a powerful voice and as doors open into public spaces – collaboration is possible for a community to find a solution to the pollution.

BIBLIOGRAPHY

Alam, R. (2019). In Making Comics, Lynda Barry Shares the Secrets of Her Success. *New Republic*. Retrieved from https://newrepublic.com/article/155870/making-comics-lynda-barry-shares-secrets-success

Alerby, E. (2000). A Way of Visualizing Children's and Young People's Thoughts about the Environment: A Study of Drawings. *Environmental Education Research, 6*(3), 206 and 207.

Alerby, E. (2015). *A Picture Tells More than a Thousand Words: Drawings Used as Research Method*. Rotterdam: Springer.

Alerby, E. (2019). Places for Silence and Stillness in Schools of Today: A Matter for Educational Policy. *Policies for Future Education, 17*(4), 531-534.

Alerby, E., U. Bergmark. (2012). What Can an Image Tell? Challenges and Benefits of Using Visual Art as a Research Method to Voice Lived Experiences of Students and Teachers. *Journal of Arts and Humanities*, 95-104.

AmericanRivers.org. What Makes A River.

Banister, F. a. C. R. (2001). Developing Science Concepts Through Story-Telling. *The School Science Review, 83*(302), 75.

Barry, L. (2019). *Making Comics*. Montreal, Quebec: Drawn and Quarterly.

Benjamin, W. (1936). *Selected Writings - The Work of ARt in the Age of Its Technological Reproducibility: Second Version.* (H. E. a. O. Edmund Jephcott, Trans. Vol. 3). London: England: The Belknap Press of Harvard University Press.

Bennett, N., et al. (2017). Environmental Stewardship: A Conceptual Review and Analytical Framework. *Environment Management, 61*, 597-598.

Bennett, S. (2018). Is There a Role for Art in Policymaking? *A Political,* (23 June 2021). Retrieved from https://apolitical.co/solution-articles/en/role-art-policymaking

Blaut, J. M. (1997). The Mapping Abilities of Young Children Can. *Annals of the Association of American Geographers, 87*(1), 152.

Blaut, J. M., David Stea, Christopher Spencer and Mark Blades. (2021). Mapping as a Cultural and Cognitive Universal. *Annals of the Association of American Geographers, 20*(7:54), 165.

Brooks, M. (2009). Drawing, Visualization and Young Children's Exploration of Big Ideas. *International Journal of Science Education, 31*(3), 319, 326 and 340.

Bruner, J. (1986). *Actual Minds, Possible Worlds*. Cambridge, Massachusetts: Harvard University Press.

Butt, G. (2011). Globalisation, Geography Education and the Curriculum: What Are the Challenges for Curriculum Makers in Geography? . *Curriculum Journal, 22*(3), 423-438.

Caiman, C. (2015). Naturvetenskap I tillblivelse-barns meningsskapande kring biologisk mangfald och en hallbar framtid. *Stockholm University*, 22.

Caiman, C., and Britt Jakobson. (2019). The Role of Art Practice in Elementary School Science. *Science and Education, 28*(102), 153 and 154.

Caiman, C., and Iann Lundegard. (2018). Young Children's Imagination in Science Education and Education for Sustainability. *Cultural Study of Science Education, 13*, 687 and 701.

Census.gov. Portsmouth Public Schools Second Grade Population. Retrieved from https://www.census.gov/quickfacts/portsmouthcityvirginia

Chawla, L. (1999). Life Paths Into Effective Environmental Action. *The Journal of Environmental Education, 31*(1), 19.

Chellaney, B. (2020). Preventing the Death of the World's Rivers. Retrieved from https://chellaney.net/2020/02/08/preventing-the-death-of-the-worlds-rivers/

Chen, P. a. D. M. (2004). Visualize, Visualize, Visualize: Designing Projects for Higher-Order Thinking. *Learning and Leading with Technology, 32*(4), 55 and 57.

Cockburn, T. (1998). Children and Citizenship in Britain. *Childhood, 5*(1), 113.

Cockburn, T. (2005). Children as Participative Citizens: A Radical Pluralist Case for 'Child Friendly' Public Communication. *Journal of Social Sciences, 9*, 19 and 27.

Cockburn, T. (2007). Partners in Power: A Radically Pluralistic Form of Participative Democracy for Children and Young People. *Children & Society, 21*(6), 446-457.

Cockburn, T. (2009). Children and Deliberative Democracy in England. In *Handbook of Children's Participation: Perspectives from Theory and Practice* (pp. 306-315). London: Routledge.

Cope, M. P., E. A. Mikhailova, C. J. Post, M. A. Schlautman and P. Carbajales-Dale. (2018). Developing and Evaluating an ESRI Story Map as an Educational Tool. *Natural Sciences Education, 47*, 1.

Cox, S. (2005). Intention and Meaning in Young Children's Drawing. *International Journal of Art and Design Education, 24*(2), 123.

Delice, A. (2018). The Sampling Issues in Quantitative Research. *Educational Sciences: Theory & Practice, 10*(4), 2001-2004. Retrieved from https://eric.ed.gov/?id=EJ919871

Dove, J. E., L.A. Everett and P.F.W. Preece. (1999). Exploring a Hydrological Concept through Children's Drawings. *International Journal of Science Education, 21*(5), 485 and 486.

Dunbar, R. (2021a). Elizabeth River Story Map. Retrieved from https://storymaps.arcgis.com/stories/91d0bd371c8b46d8adfa97faadd78090

Dunbar, R. (2021b). Riverology: Inquire, Visualize, Draw, Share, Act and Reflect. Retrieved from https://www.riverology.org/riverology

Egan, K. (1986). *Teaching as Storytelling: An Alternative Approach to Teaching and Curriculum in the Elementary School*. Chicago: University of Chicago Press.

Egan, K. (1997). *The Educated Mind: How Cognitive Tools Shape Our Understanding*. Chicago: University of Chicago Press.

Egan, K. (2005). *An Imaginative Approach To Teaching*. San Francisco, California: Jossey-Bass.

Einarsdottir, J., Sue Dockett and Bob Perry. (2009). Making Meaning: Children's Perspectives Expressed Through Drawings. *Early Childhood Development and Care, 179*(2), 229. Retrieved from https://www.tandfonline.com/loi/gecd20

ElShafie, S. (2018). Making Science Meaningful for Broad Audiences through Stories. *Integrative and Comparative Biology, 58*(6), 1213.

Fettes, M. (2013). Imagination and Experience: An Integrative Framework. *Democracy and Education, 21*(1), 1 and 3.

Fox, J. a. J. L. (2013). When Children Draw vs When Children Don't: Exploring the Effects of Observational Drawing in Science. *Creative Education, 4*(7A1).

Fredericks, L., Eve Kaplan and Jennifer Zeisler. (2001). *Integrating Youth Voice in Service Learning*.

Galani, A. a. A. R. (2014). An Investigation of Hand-Drawn Representations of Rivers by Fifth-Grade Students in Greek Elementary Schools. *ISRN Education, 2014*, 1.

Gatt, S. a. G. T. (2012). Inquiry-Based Learning in the Early Years Through Storytelling. *JES4*(winter), 19 and 24.

Gershon, N. a. W. P. (2001). What Storytelling Can Do or Information Visualization. *Communication of the ACM, 44*(8), 31.

Gholam, A. (2019). Inquiry-Based Learning: Student Teachers' Challenges and Perceptions. *Journal of Inquiry and Action in Education, 10*(2), 112-113.

Gilbert, J. K. (2005). A Metacognitive Skill in Science and Science Education. *Visualization and Science Education*, 9.

Golledge, R. G. (2002). The Nature of Geographic Knowledge. *Annals of the Assocication of American Geographers, 92*(1), 1-14.

Goodnow, J. J. (1988). Parents, Ideas, Actions and Feelings: Models and Methods from Developmental and Social Psychology. *Child Development, 59*, 286-320.

Green Chemistry Sustainability. (2020). *Plasticized Childhood: The Impact of Plastic Toy Advertising to Children on Their Health and Environment*. Retrieved from Brazil: University of Sao Carlos:

Habermas, J. (1974). *The Public Sphere* (Vol. 3): Duke University Press.

Habermas, J. (1984). *The Theory of Communicative Action* (Vol. 1). Boston, Massachusetts: Beacon Press.

Habermas, J. (1990). *Moral Consciousness and Communicative Action*. Cambridge, MA: MIT Press.

Habermas, J. (1991). *The Structural Transformation of the Public Sphere: An Inquiry Into a Category of Bourgeois Society*: Massachusetts Institute of Technology.

Harlen, W. (2013). Inquiry-Based Learning in Science and Mathematics. *Riview of Science, 7*(2), 11 and 31.

Hartsfield, T. (2013). *Service Learning Reflection Toolkit*. Portland, Oregon: Northwest Service Academy.

Hicks, D. a. C. H. (1995). *Visions of the Future: Why We Need to Teach for Tomorrow* University of Michigan: Trentham Books.

Hulland, C. a. H. M. (1994). Science, Stories and Sense-Making: A Comparison of Qualitative Data from a Wetlands Unit. *Science Education, 78*, 117-136.

Judson, G. a. K. E. (2017). The Imagination as the Great Workhorse of Learning. In *The Works of Imagination: Perspectives and Modelizations* (pp. 1 and 7). Pessoa, Brazil: Federal University of Paraiba.

Kaatz, K. (2008). A Walk in the Tall, Tall Grass. *Science and Children, 45*, 28-31.

Kerr, M. (2016). *Conservation Storytelling.* (Masters Professional Placement Report). University of Cambridge, England.

Kirby, P., Claire Lanyon, Kathleen Cronin and Ruth Sinclair. (2003). *Building Culture of Participation*: The National Children's Bureau.

Kroeber, K. (1992). *Retelling/Rereading: The Fate of Storytelling in Modern Times*. New Brunswick: Rutgers University Press.

Lauwers, H. a. W. V. (2005). Spatial Planning and Opportunities for Children's Participation: A Local Governance Network Analysis. *Children, Youth and Environments, 15*(2), 287.

Lebreton, L., Joost van der Zwet, Jan-Willem Damsteeg, Boyan Slat, Anthony Andrady and Julia Reisser. (2017). River Plastic Emissions to the World's Oceans. *Nature*(June), 11.

Li, C. J. a. M. C. M. (2017). Exploring the Essential Psychological Factors in Fostering Hope Concerning Climate Change. *Environmental Education Research*(August), 1.

Loftis, D. (2020). Rising Sea Level Research Showcased on NASA Science LIVE. *NASA Earth Science Applied Sciences*. USA.

Mackintosh, M. (2005). Children's Understanding of Rivers. *International Research in Geographical and Environmental Education, 14*(4), 316-322.

Malchiodi, C. (1998). *Understanding Children's Drawings*. New York, NY: The Guilford Press.

Martin, C. (2018). Should Deliberative Democratic Inclusion Extend to Children? *Democracy and Education, 26*(2).

McWhirter, J. M., M. Collins, I. Bryant, N.M. Wetton and J. Newton Bishop. (2000). Evaluating 'Safe in the Sun', a Curriculum Programme for Primary Schools. *Health Education Research, 15*(2), 203.

Mulholland, M. (2019). As High-Tide Flooding Worsens, More Pollution is Washing to the Sea. *Yale Environment 360*. Retrieved from https://e360.yale.edu/features/as-high-tide-flooding-worsens-more-pollution-is-washing-to-the-sea

National Science Education Standards. Retrieved from http://www.csun.edu/science/ref/curriculum/reforms/nses

Negrete, A. a. C. L. (2004). Learning from Education to Communicate Science as a Good Story. *Endeavor, 28*(3), 120.

NOAA.gov. (10 May 2021). U.S. High-Tide Flooding Continues to Increase: New Report Shows Record-Breaking Coastal Flooding Due to Sea Level Rise, Expected to Continue Into 2021. Retrieved from https://www.noaa.gov/media-release/us-high-tide-flooding-continues-to-increase

Norfolk.gov. The Elizabeth River. Retrieved from https://www.norfolk.gov/2359/Elizabeth-River

Ozsoy, S. a. B. A. (2014). Elementary School Students' Perceptions of the Future Environment through Artwork. *Educational Sciences: Theory & Practice*, 1570-1582.

Padian, K. (2018). Narrative and "Anti-narrative" in Science: How Scientists Tell Stories, and Don't. *Integrative and Comparative Biology, 58*(6), 1233.

Patel, P. (2018). Stemming the Plastic Tide: 10 Rivers Contribute Most of the Plastic in the Oceans. *Scientific American*, 2.

Phillips, L. (2010). *Young Children's Active Citizenship: Storytelling, Stories and Social Actions.* (Doctor of Philsophy). Queensland University of Technology, Australia

Phillips, L. (2014). *I Want To Do Real Things: Explorations of Children's Activit Community Participation*. Routledge, London.

Register, K. (2012). Turning the Tide on Trash. In N. M. D. Program (Ed.).

Register, K., and L. McKay. (2016). *Virginia Marine Debris Reduction Plan*: Virginia Coastal Zone Management.

Reiss, M. J. e. a. (2002). An International Study of Young People's Drawings of What is Inside Themselves. *Journal of Biological Education, 36*, 58-64.

Rennie, L. a. T. J. (1995). Children's Choice of Drawings to Communicate Their Ideas about Technology. *Research in Science Education, 25*, 239.

Root-Bernstein, R. S. (1996). *The Sciences and Art Share a Common Creative Aesthetic*. Dordrecht: Kluwer Academic Publishers.

Schmidt, C., Tobias Krauth and Stephan Wagner. (2017). Export of Plastic Debris by Rivers Into the Sea. *Environmental Science and Technology, 51*, 12246.

Semuels, A. (2021). Garbage Freaking Everywhere as Americans Venture Outdoorsd After a Year of Lockdowns. *Time.com*. Retrieved from https://time.com/5949983/trash-pandemic/

Strachan, C. a. J. M. (2014). Teachers' Perceptions of Esri Story Maps as Effective Teaching Tools. *Review of International Geographical Education Online, 4*(3), page 195.

Strommen, E. (1995). Lions and Tigers and Bears, Oh My! Children's Conceptions of Forests and Their Inhabitants. *Journal of Research in Science Teaching, 32*(7), 683.

Teixera, F. M. (2000). What Happens to the Food We Eat? Children's Conceptions of the Structure and Function of the Digestive System. *International Journal of Science Education, 22*, 507-520.

Tompkins, F. a. C. D. (2014). Sea-Level Rise and Its Impact on Virginia. *The World Resources Institute*(June), 1.

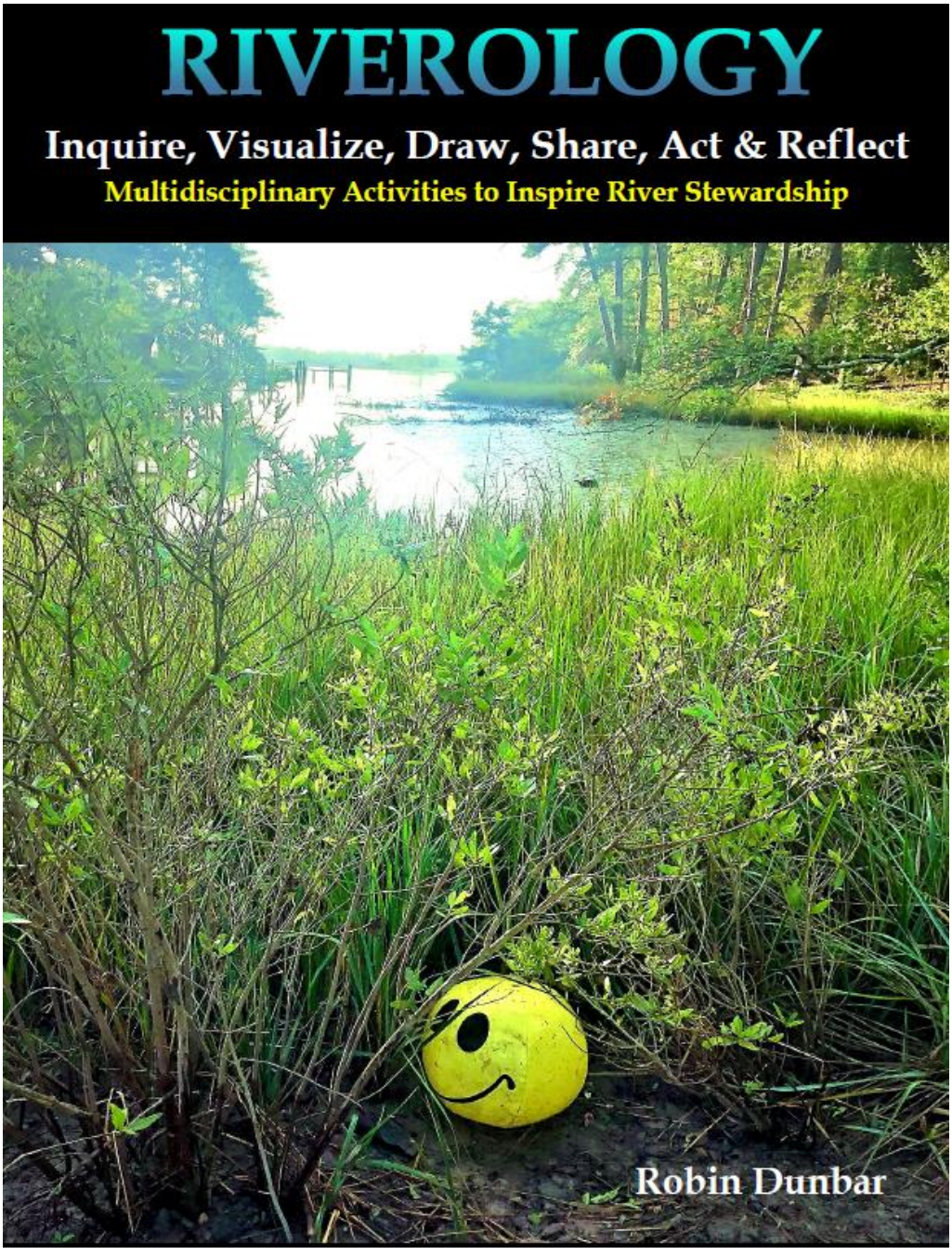
Tuan, Y.-F. (1991). A View of Geography. *Geographical Review, 81*(1), 99.

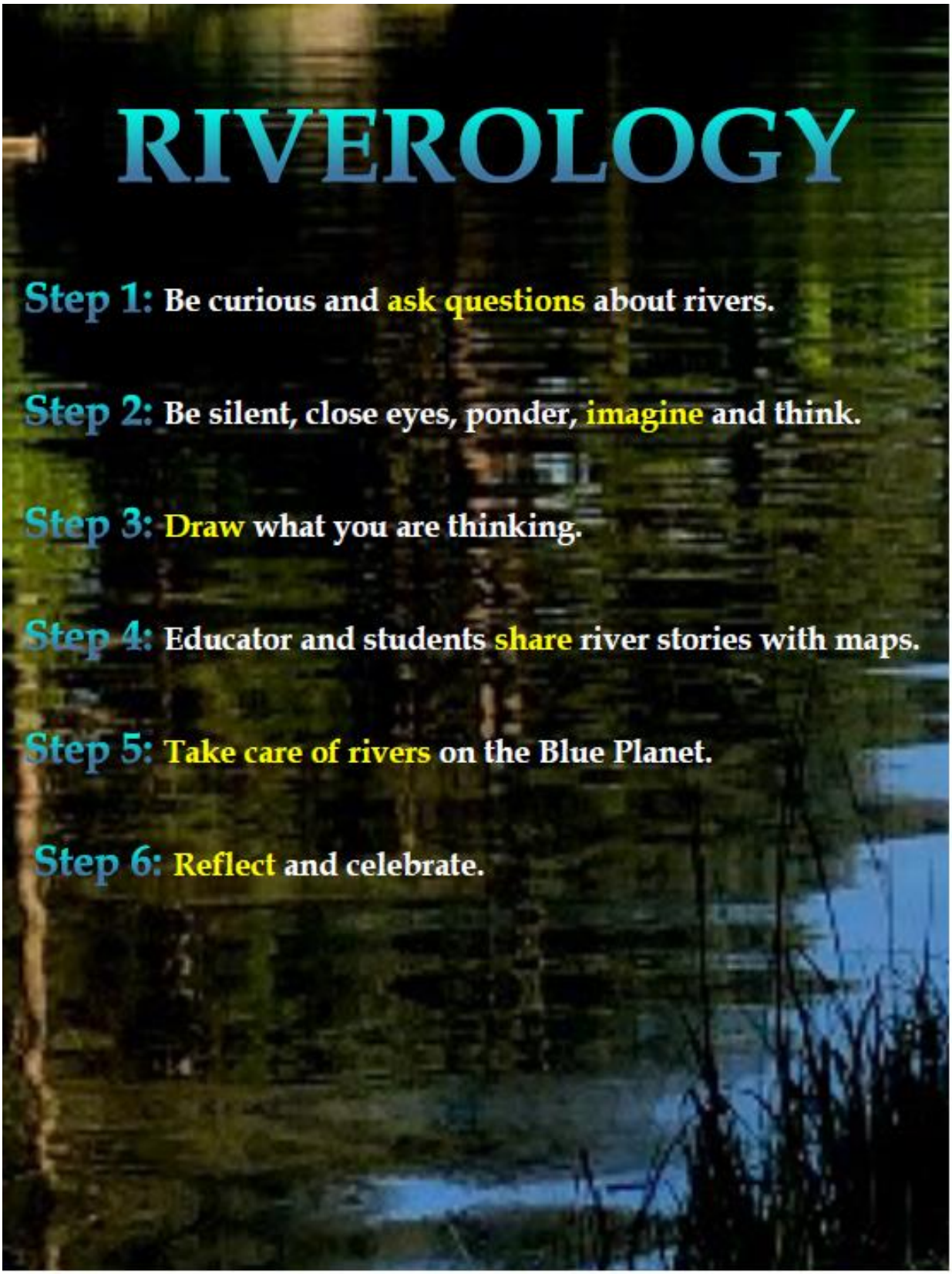
Vins, H., Amber Wutich, Alexandra Brewis, Melissa Beresford, Alissa Ruth and Christopher Roberts. (2014). Children's Perceived Water Futures in the United States Southwest. *Society of Applied Anthropology, 73*(3), 236 and 244.

Virginia Department of Education. Standards of Learning. Retrieved from https://www.doe.virginia.gov/

APPENDIX A

RIVEROLOGY CURRICULUM




RIVEROLOGY
Step 1: Be curious and ask questions about rivers.
Step 2: Be silent, close eyes, ponder, imagine and think.
Step 3: Draw what you are thinking.
Step 4: Educator and students share river stories with maps.
Step 5: Take care of rivers on the Blue Planet.
Step 6: Reflect and celebrate.
2

This large piece of polystyrene washed ashore from the Western Branch of the Elizabeth River.

Elizabeth River restored wetlands at Grandy Village Learning Center, Norfolk, Virginia.

What's RIVEROLOGY?

Educators use *RIVEROLOGY: Inquire, Visualize, Draw, Share, Act and Reflect* to teach, inspire, empower and engage youth to care for their home river and find solutions to the challenges they face with litter and marine debris. Rivers drain nearly 75% of the earth's land surface. Rivers provide excellent habitat and food for many of the earth's organisms.
Source: American Rivers.

What is RIVEROLOGY? It's the study of rivers, at least that is what it means to me. It's not a widely used term and it's certainly not official as my computer continually highlights the word every time I type it alerting me the word is nonexistent. Britannica.com defines river as, "any natural stream of water that flows in a channel with defined banks, downhill towards the ocean. The suffix –ology means a subject of study or a branch of knowledge.

When reflecting on my 20-years teaching about a polluted river, I came to the conclusion I'm a "Riverologist" (another term my computer alerts is nonexistent). I'm not a river expert, but instead a student. I absolutely don't know everything about rivers - who could? For decades, I've studied my home river through the eyes of children, the lens of science, my senses, art and my imagination. My riverology journey led me to become a lifelong river steward with a goal to shine the light on the importance of healthy rivers and foster a world of riverologists.

I've learned a lot about rivers through the marriage of art of science. For me this includes storytelling, painting, costumes, innovations and environmental curriculums combined with science that inspires wonder and gives a basis for understanding why things happen and predicting what might happen next. Science can show patterns and present the benefits and risks of our actions while helping us understand possibilities. This powerful duo of art that helps us tell the story and science that inspires understanding, strengthens communities to protect our rivers. Rivers flow through our towns reflecting "us" our culture and history.

Our children are also caretakers of earth and as teachers and mentors we can provide opportunities to be quiet, ponder, imagine and share ways to continue to care for our rivers.

Robin Dunbar, a professed riverologist.

RIVEROLOGY

Elizabeth River is Tired. Items such as tires are dumped in the rivers. Out of sight—Out of Mind.

Acknowledgements

I would like to thank all the stewards of rivers and oceans and all those who foster our children to be engaged, informed and inspired to take care of the Blue Planet.

~ River love to you all! ~

Robin

Smiley face ball washed into the Elizabeth River wetlands.

Ms. Dunbar is an award-winning environmental educator and storyteller, a certified National Geographic Educator, and recipient of the 2019 Presidential Award of Excellence in Science, Mathematics, Engineering and Mentoring from the National Science Foundation and the White House. She has a twenty-year career as the Deputy Director of Education with the nonprofit Elizabeth River Project with education platforms including the Dominion Energy Learning Barge, the Barge on Wheels, Paradise Creek Nature Park and Youth Resilience River Star Schools, Strategy and Expo. As a storyteller, she portrays the river's namesake, Princess Elizabeth, delivering a message of hope for restoring our river and utilizes her original stories, art and costumes. Learn more at www.riverology.org.

RIVEROLOGY

How to Use the Curriculum

There are 10 RIVEROLOGY Lessons

Lesson 1
What Does Earth Look Like?

Lesson 2
What Do You Know About Your River?

Lesson 3
What's a Flying Bird's View of Your River?

Lesson 4
What's On the Bottom of the River?

Lesson 5
How Does Pollution Get in the River?

Lesson 6
What Does the River Look Like After a Storm?

Lesson 7
What Does Sea Level Rise Look Like?

Lesson 8
What Do River Plants and Animals Look Like?

Lesson 9
What Does a River Superhero Look Like and Do?

Lesson 10
What Will Your River Look Like in the Future?

Each Activity Includes the Same 6 Steps

Step 1: **Inquire** (A question is asked.)

Step 2: **Visualize** (Student's close eyes and think.)

Step 3: **Draw** (Students complete 2 drawings - one before and one after they hear a story. Students draw what they were thinking when asked the inquiry question.)

Step 4: **Share** (Students share what they drew and teachers share info. with stories and maps.)

Step 5: **Act** (Students learn and implement actions to help rivers.)

Step 6: **Reflect** (Students take time to think about the activity, actions and future.)

RIVEROLOGY Overview

In summary, students are asked an inquiry question and then given time to draw what they are thinking. Students then share what they drew with the class and teachers take notes about the drawings on an evaluation sheet. Teachers then present a story that complements the inquiry question and utilize maps as appropriate. Students then draw another drawing and teachers compare the pre– and post– drawings noting the differences. Students take action and reflect.

Before Implementing Activities

NOTE: There are steps the educator should do before implementing the activities. Although the activities are outlined and include resources - educators should have a basic knowledge about the Blue Planet and rivers before beginning.

In addition, the educator needs to decide what criteria to measure that reflects the river the students are learning about and develop an Evaluation Template to utilize when analyzing the student's drawings. The evaluations are utilized to review the class as a whole versus each student. The drawings should not be for a grade, but instead a tool for the students to communicate what they are thinking.

Before and After, Results of an Elizabeth River volunteer cleanup.

Educator's To Do List

1.) **Learn about rivers.** Information about rivers can be found of page 12, but also consider your own research.

2.) **Learn about your home river(s).** This curriculum utilizes the Elizabeth River in Virginia as a model, but all rivers are different and include different challenges, plants, animals, etc. Collect maps, photos, artifacts and more. Reach out to local resources for more.

3.) **Learn how to utilize maps** in stories. I recommend these resources, but there are others: ArcGIS (Use Google Chrome Browser), NOAA, Google Earth/ Maps, USGS and National Geographic, local libraries and Library of Congress. Instructions for map activities are included in the activities.

4.) **Review the 10 RIVEROLOGY lessons** and choose the lessons you would like do.

5.) **Develop an evaluation template for each lesson or use the one provided.** Begin by deciding what you would like to know by the end of the activity. Then make a list of criteria you will look for in the pre– and post– drawings.

6.) **Develop an engaging 15-minute story that utilizes maps.** Consider adding props, news articles and artifacts. Make the story dynamic, engaging and entertaining.

7.) **Make sure you have art paper and drawing tools** such as colored pencils, crayons, pastels or paint.

8.) **Highlight challenges of the river** you are focusing on.

RIVEROLOGY

Restored wetlands at Paradise Creek Nature Park on the Elizabeth River's Southern Branch, Portsmouth, Virginia. The public can launch a kayak at the park and paddle the wetland's maze.

Photographs are by Robin Dunbar or unless otherwise noted by Storyblocks. Ms. Dunbar can be contacted at rdunb002@odu.edu or baybabies.org@gmail.com for permission to use.

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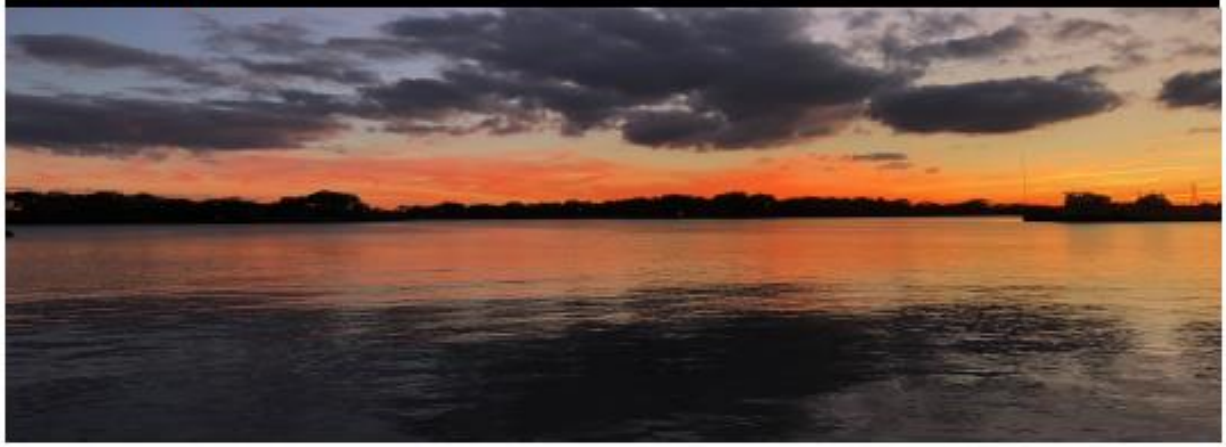


About Rivers

What's a river? Britannica.com say a river is any natural stream of water that flows in a channel with defined banks downhill towards the ocean. Rivers are the circulatory system of the continents (Gomi et al., 2002).

Do river's hold a lot of Earth's water? Rivers contain less than 1% of the world's water and there are about 165 major rivers in the world and thousands of smaller ones.

What is the major river of the United States? Missouri: 2,340 miles

What is a tributary? It's a river or stream flowing into a larger river or lake.

What's an estuary? Estuaries are bodies of water where rivers meet the sea or a large lake.

What lives in and around a river? People, plants and animals such as fish, birds and wild-life. Some rivers are salty, some brackish and some fresh and this can dictate what types of plants and animals are in a river's ecosystem.

What do rivers look like? Rivers can be long, short, wide or narrow and often join to make bigger rivers. The color of a river is associated with different wave lengths within the light spectrum. Water that is blue has a very low amount of dissolved particles in it. Students should learn the difference between the apparent color and true color of water. The apparent color is when looking at it. The true color after the suspended particles have been removed. Suspended particles include algae, sediments, or minerals. Dissolved particles are things such as tannins—a dye (a yellowish-brown organic acid that is found in plant tissues), or particles of iron and manganese from rocks or soil. The most common cause for water to change color is minerals. Minerals from rock are dissolved and small pieces are released into the water causing different colors. Rivers can also change color temporarily such as after storms when many rivers run brown from all the runoff flowing into the river. Clay can cause muddy rivers.

How do rivers form and move? A river's origin is called its source and the end its mouth. Most rivers start with rain or snow and run downhill (downstream) and forms a creek that forms a stream that then forms a river. Some rivers come from springs that bubble up or spill out. A river forms from water moving called a current from a higher elevation to a lower elevation, all due to gravity. There can be erosion with constant movement, but some rivers don't always move.

What happens to a river when it rains? When rain falls on the land it either seeps into the ground or becomes runoff, which flows downhill into rivers and lakes on its journey towards the seas. Rain water doesn't have any salt in it and is called 'fresh water'. When it rains some of the water is absorbed into the soil and helps plants to grow, some of the water sinks deep into the ground and some of it flows into rivers and down to the sea. Lots of rain can cause flooding.

What are benefits of rivers? Rivers carry large quantities of water from the land. Rivers can be used for lots of good things, like recreation, transportation, trade of goods, fisheries, habitat, beauty and farming. Some provide water to drink and energy we convert to electricity.

What are the longest rivers in the world? the Nile, the Amazon–Ucayali Apurímac, the Yangtze, the Mississippi–Missouri –Red Rock, and the Yenisey–Baikal–Selenga.

Are all river's swimmable and fishable? No. You should always check with your local, state and federal water monitoring agencies to see if the river meets the approved standards for swimming and fishing. Also, some rivers have very strong currents and if the ground is steep then the currents will be stronger. Observation reasons not to go in a river would be:

1.) If there is algae everywhere.
2.) The current is faster than you can swim.
3.) There are warning signs posted.
4.) You're near a spot where two rivers merge.
5.) The river is near a pasture or farmland.
6.) Narrow shallow bodies of water don't flush and may have excess bacteria.
7.) Debris could be present causing injuries. If cut, watch for redness and swelling and seek medical attention immediately. Don't go into a river if you have cuts, burns or abrasions. Always wash hands and avoid water getting in your mouth/nose.

What are threats to rivers? Environmental stressors include runoff, litter and marine debris pollution, invasive species, lack of public access, extreme weather (flooding and drought), lack of plants and wetlands and inaction—lack of stewardship.

Snail. This is done by applying paint to your palm and thumb only; press down on paper and then add eyes.

RIVEROLOGY

A Model Elizabeth River

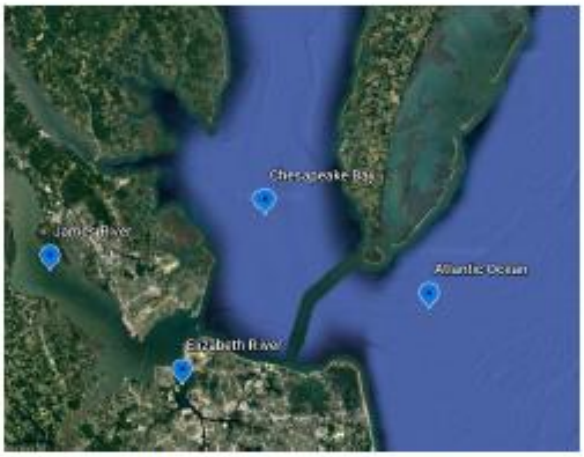
The RIVEROLOGY curriculum showcases the Elizabeth River in Virginia as teaching model.

The Elizabeth River is connected to the Chesapeake Bay, the largest estuary in the United States and third largest in the world—and the bay is connected to the Atlantic Ocean. Brackish water (a mix of saltwater and fresh) fills most of the Bay. The river is the located at the bottom of the bay and is one of the closest river's to the Atlantic Ocean. The river runs through four cities, Norfolk, Portsmouth, Chesapeake and Virginia Beach with about 500,000 people (about 155,000 youth under 18) www.census.gov. The Elizabeth River is a working and liv]0poing river and is home to the world's largest naval base, the Norfolk Naval Shipyard and a world-class port.

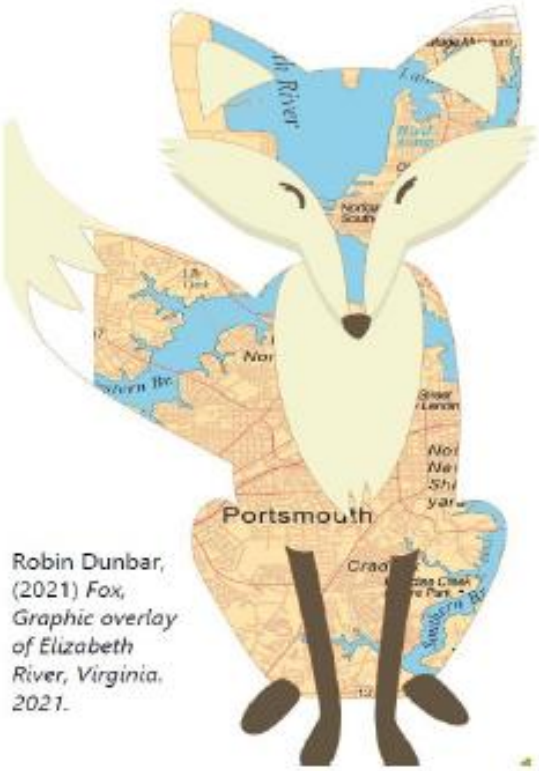
The Elizabeth River is one of the most polluted rivers of the Chesapeake Bay, has the highest sea level rise on the eastcoast of the United States and lost 50% of wetlands over time. Challenges include a lack of public access, bacteria, marine debris and flooding.

Wildlife include: red fox, river otter, osprey, great blue heron, brown pelican and raccoons.
Wetland grasses include: *Spartina alterniflora and Spartina patens.*
Aquatic animals include: Atlantic blue crab, eastern oyster, mummichog, croaker, spot, white perch, striped bass and oyster toad fish.

Click here for Elizabeth River Resources



Google Earth Image of the Elizabeth River, a tributary of the James River. The Elizabeth River is at the mouth of the Chesapeake Bay and the Atlantic Ocean.



Robin Dunbar, (2021) *Fox, Graphic overlay of Elizabeth River, Virginia. 2021.*

My Home River Prep

Below are items to research about YOUR home river to personalize the RIVEROLOGY activities.

Do NOT share your river information before a visualizing activity.

The goal is to let the students ponder, visualize and imagine first.

This is necessary for evaluating and comparing drawings before and after stories are shared.

RIVEROLOGY

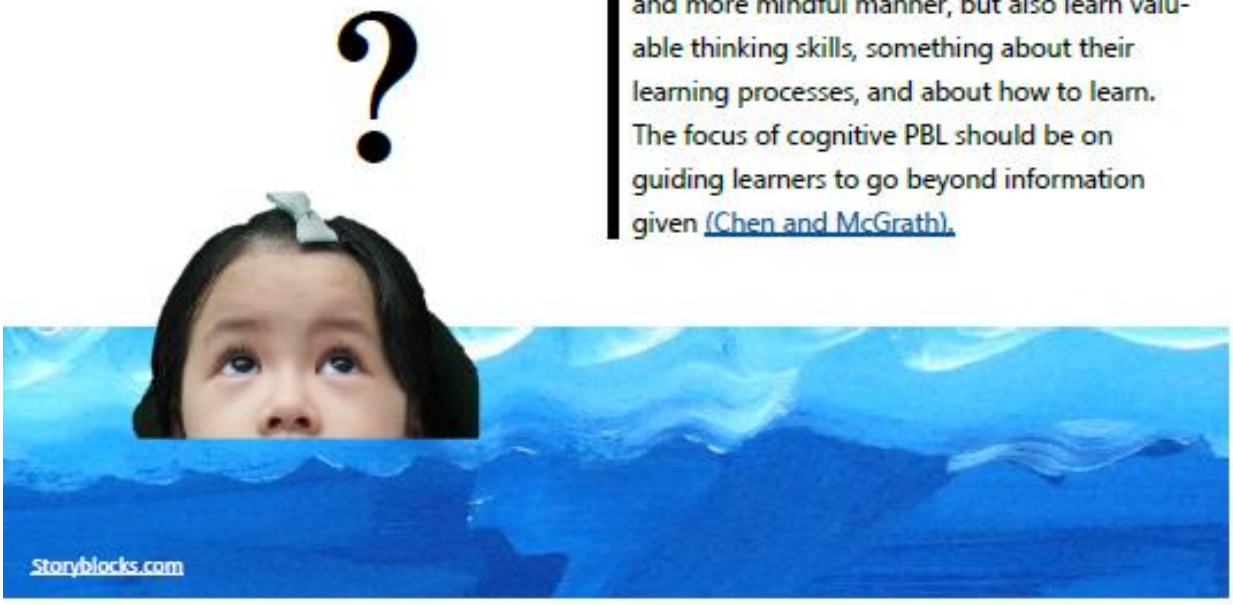
STEP 2: Visualize

Visualize, visualize, and visualize the thinking process

~ Chen and McGrath.

Visualization is the creating or recreating of imaginary or real scenes within one's mind. Visualization can be enriched by utilizing the senses such as with touch, sound and taste. **Visualization is central to learning, especially in the sciences,** for students have to learn to navigate within and between the modes of representation (Gilbert). Thinking is the process of being in a changing world and we are dependent on the world in different ways (Albery). With that greater access might come greater opportunity to create.

Youth need cognitive space and flexibility for exploring and thinking and visualization can be fun! As long-time Harvard educational researcher D. N. Perkins, in his book *The Mind's Best Work*, has reminded us, "We have more access to our minds." In cognitive problem based learning (PBL), students not only process knowledge content in a deeper and more mindful manner, but also learn valuable thinking skills, something about their learning processes, and about how to learn. The focus of cognitive PBL should be on guiding learners to go beyond information given (Chen and McGrath).



STEP 3: Draw

Drawing can help children make their ideas visible and assist in the exploration of their questions about the world in which they live. Drawing has the potential to play a role in the visualization of ideas in relation to young children exploring science concepts (Brooks). **Most young children have a strong desire to draw** since drawing can provide children their first means of making a permanent, tangible, communicable record of their ideas.

Drawing is a means of communication and a problem-solving tool. Through drawing, they can see what they are thinking and play around with their ideas (Brooks). Not everything can be communicated verbally – there is also a silent language that can appear in different art forms and it can express something in the same way that spoken or written words can (Merleau-Ponty). Humans are not solely able to express themselves through speech and writing, but also through images.

The question is not what they have drawn, but about their experiences depicted in the drawings (Alerby 2003). It's important the students understand that it doesn't matter how skilled they are at drawing and that the drawings are about expressing their thoughts. Using multiple ways of expression such as drawings combined with a student oral presentation will enrich the understanding (Alerby 2015). Students can use different kinds of tools to draw -.not just pencils.

Students should be given at least 15-minutes to draw what they are thinking in the RIVEROLOGY activities.

Eyes on the River. Poster paint on newspaper glued to hula hoops. Students learned about fish in the Elizabeth River and then drew their eyes on a paper plates that Ms. Dunbar reproduced on the larger hula hoop canvases.

RIVEROLOGY

The RIVEROLOGY Process:

Inquire, Visualize, Draw, Share, Act & Reflect

STEP 1: Inquire

Children are curious and inquisitive – they wonder. Asking good questions is key to the inquiry process and the activities that follow help students develop research skills and provide practice in asking questions too. In this digital age, answers may be at the touch of a button, but children should experience how to take time and "ponder" - wonder with patience and think. Inquiry-based learning engages them in exploring questions they have about nature and the world around us.

The most long lasting inquiry-based learning is aligned with children's language, culture, community traditions and talents and it also comes from the children's interests—what is intriguing, enticing and puzzling. For the teacher, the inquiry process includes teachers observing, documenting and reflecting on the children's nature learning (Meier). A good example would be Jane Goodall that used her listening, watching, feeling and thinking skills.

Trash on the shore at Elizabeth River's Knitting Mill Creek during low tide.

Google Satellite Image of the Elizabeth River.

Geo-Inquiry

The Geo-Inquiry Process builds on students questions that reflect their interests and issues in their local community. It includes action or a stewardship project. It is usually done as a whole group (class) answering a question.

The study of geography helps to comprehend how the world works and the relationship of people and places, environments, and why things are where they are and how they change over time. This process includes combining geography (maps) with inquiry. It can be

RIVEROLOGY vs Geo-Inquiry

RIVEROLOGY process prioritizes students visualizing where the Geo-Inquiry process prioritizes students researching. Teachers include research for storytelling with maps, props and artifacts. In addition, the "visualize step" focuses on students closing their eyes, "thinking and pondering" where National Geographic's Geo-Inquiry Visualizing Phase is about creating maps with stories and data. There is value in both.

Click for National Geographic Source.

	RIVEROLOGY PROCESS	GEO-INQUIRY PROCESS
Inquire	Inquiry question provided.	Students develop an inquiry question.
Visualize	Students are quiet, close their eyes, think, ponder and imagine.	Students utilize maps to organize their thoughts, stories and data.
Create	Teachers gather info. for stories, but otherwise this is not part of the RIVEROLOGY process. Students draw a picture about what they are thinking.	Students conduct research and choose visuals such as storyboards to share their information.
Share	Teachers present a story and information about rivers and students share their drawings.	Students have dialogues with their teachers and teams and discuss how to present their ideas.
Act	Stewardship actions are recommended related to creating a healthy river.	Students share their ideas with an audience through web, posters and events.
Reflect	Students are given time to think about what they learned and will do to help their home river and then celebrate their achievements with a menu of options.	This phase is call as Assessment and students answer prompts and then discuss as a class what they liked and would change.

Student envisions what the Blue Planet looks like utilizing acrylic paints.

Teachers share stories and the students share what they were thinking when creating their drawings.

STEP 4: Share

Storytelling and dialogue are a part of every child's life (Huffaker). Stories are universal (Hogan). Stories give context, stir emotions and allow tellers and listeners the chance to "reevaluate the world and their place in it" (Svoboda). This is important when learning about and forming connection to rivers. Storytelling has the power to engage the children, but there is a limit - 15 minutes max (Banister and Ryan).

Storytelling is an exciting way to develop children's science ideas and to make their science learning more memorable (Banister and Ryan). Storytelling can also stimulate the imagination (Egan). After hearing stories, the students may change their ideas - and some more than others. As stories are easily incorporated into the memory (Weber), story-telling may help children link chains of cause and effect and so improve their science learning (Banister and Ryan).

Include time for students to share what they drew. This is an enriching part of the process and the teacher should gain information as part of the evaluation. For example, a student may draw dark oval shapes on the surface of the river. That could be interpreted as fish, leaves, litter or pet waste. Interpretation is key. Images are susceptible to uncertainties and may need dialogue to clarify (Gershon).

Tell Me About Your Drawing

Students explaining what they drew should be enlightening. Providing the opportunity for students to share what they were thinking by sharing their drawings - before listening to a teacher led story - may illuminate a range of ideas that were already present. Depending on what is revealed, this should prompt a series of questions to elicit understanding (Mackintosh).

Allowing the students to share, shouldn't include expressions of disappointment, but instead should be more of an "interview - seeking meaning." By allowing students to share, the evaluation of the interpretation of the drawing's meaning should be more accurate and the results should help guide teaching.

Allowing students to reflect on their drawings and share is important. Providing a second opportunity to share what they drew may reveal additional information. The students will have time to reflect and may remember something they were thinking about that they didn't share previous (Weber).

STEP 5: Act

Creating a Culture of Participation

Everyone should play a role in taking care of the Blue Planet, but students are critical to engage in Earth stewardship for they have the passion to make a difference in shaping Earth's future (Chapin, et al). For there to be change, youth need to be involved and their voices heard to make it meaningful. This includes dialogue, observation, listening, decision-making and engaging in activities (Kirby, et al).

Stewardship is a social-ecological framework for sustaining life in a rapidly changing world (Chapin, et al). We must work together as it will require repair (restoration), action now and planning for the future. When choosing stewardship actions for youth, make sure they are age appropriate. For example, an elementary student could help with a litter cleanup and incorporate that practice into their daily lives.

"You want me to do what?"

It's important not to shame, point fingers or promote stewardship actions as a list of chores. Youth might lack confidence that they can help or may not understand why they are fixing a mess that they didn't create. Inspire, empower and build hope.

Polystyrene washed ashore at five sites over a week in Norfolk, Virginia that are being monitored for marine debris.

"Where did it come from?"

Most importantly, rivers are the pathway to the sea and connect most of the global land surface to the marine environment. Murky water readily covers up almost anything drowned beneath its surface—out of sight and out of mind (Muller). According to NOAA (National Oceanic and Atmospheric Administration) 80% of pollution to the marine environment comes from the land and one of biggest sources is nonpoint source pollution - a result of runoff (NOAA). Nonpoint source pollution includes vehicles, vessels, septic tanks, farms and road salt. When it rains - chemicals, debris, sediments, etc. can travel to rivers via stormdrains and hard surfaces. Air pollution also plays a role along with dirt. Correcting the harmful effects of nonpoint source pollution is costly. Everyone needs to work together to restore, protect and nurture our rivers and ocean.

Debris washed ashore at Old Dominion University by the Elizabeth River, Norfolk, Virginia.

RIVEROLOGY

What Actions Can Help Rivers?

There are hundreds of stewardship actions to help Earth - but here are some actions that will specifically help rivers.

- **Pick up litter and don't be a litter bug.** Consider litter cleanup events, adopting spots and making sure there are enough trash bins. Signage may help too!
- **Reduce single-use plastics** and use reusable bags and containers.
- **Only rain should go down the storm drains.** They are meant to move rain to a nearby body of water, not litter, yard waste, pet waste, fertilizer or other items on streets, parking lots or in yards.
- **Hold onto your balloon** and don't release.
- **Pick up after your pet.** "Scoop the Poop"
- **Plant trees.** Trees do so many good things like reduce erosion, improve water and air quality, cool with shade and provide habitat
- **Create art.** Make a poster, video, signs, art, poems, stories, etc. to educate others and share your projects.
- **Do a bioblitz and count plants and animals.** Learn how here with National Geographic.
- **Reduce your Carbon Footprint.** Turn off the lights, water and walk or ride a bike.
- **Monitor the river water or marine debris.** Become a youth citizen water monitor. A local organization might provide supplies and opportunities or consider NOAA Planet Stewards or Ocean Conservancy Trash Free Seas.
- **Mentor.** Teach someone younger than you about the importance of taking care of our rivers.
- **Share your story and start a conversation.** Spark conversations with others about your home river and how you help take care of it.
- **Volunteer.** Have a parent, teacher, friend or relative help find organizations to volunteer at. It's a great way to start!

Plastics are the #1 item picked up during the annual International Coastal Cleanup

1. Food Wrappers (candy, chips, etc.)
2. Cigarette Butts
3. Plastic Beverage Bottles
4. Plastic Bottle Caps
5. Straws, Stirrers
6. Plastic Cups, Plates
7. Plastic Grocery Bags
8. Plastic Take Out Containers
9. Other Plastic Bags
10. Plastic Lids

- **Choose a career that helps rivers.**

Marine Environment Economist

Aquatic Veterinarian

Ocean (Marine) Engineer

Oceanographer

Hydrologist

Geographer

Marine Environmental Scientist

Environmental Educator

Biologist; Ecologist; Botanist

Climatologist, Meteorologists

Eco-Artist

Documentary Film Producer

Policy Changer and more!

RIVEROLOGY

A volunteer removes a food menu from the Elizabeth River.

https://oceanservice.noaa.gov/ocean/help-our-ocean.html


NEEF We All Live in a Watershed
What is a watershed?
A watershed, also called a drainage basin, is an area of land from which all water drains to a common waterway, such as a river, a lake or the ocean.
As rainwater and melting snow run downhill, they carry soil, pollutants and other materials from the land into our rivers, lakes and bays.
Watersheds are important because they provide drinking water and water for recreation, irrigation and industrial activities. They also provide food and water for plants and animals.
Watersheds consist of surface water – lakes, streams, reservoirs and wetlands – and all the underlying groundwater.
A watershed can be large or small. Some watersheds drain a few city blocks while others drain a large geographic area. The Mississippi River Basin drains 31 states before emptying into the Gulf of Mexico!
We all live downstream and our everyday activities can affect downstream waters.
Check out EPA's How's My Waterway – watersgeo.epa.gov/mywaterway – to learn more about the condition of your local water body. Use a smart phone, tablet or computer to find out if your local stream or river is polluted and what's being done to help address the problems.
Visit this site to see the health of your river. https://mywaterway.epa.gov/

RIVEROLOGY

STEP 6: Reflect

Pause

The RIVEROLOGY process would not be complete without including time to reflect and celebrate. Reflective thinking focuses on the process of critically thinking about what has happened and it provides students an opportunity to step back and review strategies, problems, processes and actions. Including some wait-time to think about inquiries is also valuable as they process scenarios, absorb information and options (Zemelman, Daniels, and Hyde).

Students should have an opportunity to reflect by themselves, but it can also be included during teacher led discussions or during student-to-student dialogues. Reflection may occur at any time during the learning process, but at a minimum at least at the end.

Reflection ends the active learning experience and begins opportunities for evaluation. This could be accomplished in many ways including with their eyes open, closed, by doodling, air drawing or talking to themselves. Students will find a way that feels most natural to them and it may be different each time. It may depend on how complex, emotional or personal something was or how involved and engaged they were.

Ways to Reflect

- **Personal Journal or Letter** - Students could create a journal or write a letter and freely write about their experience daily, weekly or periodically. These can be private.
- **Post-It Notes** - Students can write down words, doodles, sentences, etc. on post-it notes and assemble on a poster, notebook, wall, etc.
- **Songs** - Consider allowing students to share a lyric or tune from a song that describes their service action experience or participating in the project.
- **Close Your Eyes** - Allowing students time to be quiet, take some deep breaths and engage their memory is a skill that should be encouraged.

Benefits of Reflection

Was the goal accomplished? Students can reflect on the experience with or without prompted questions. Questions may make the reflection process more effective. Example of additional questions could be:

- *Did we accomplish what we wanted to?*
- *Did our actions help the river?*
- *What would I change next time?*
- *How did this river project make me feel?*

Reflection could bring closure. Taking care of the environment is an on-going commitment and the actions done today - may not last into tomorrow. Reflecting on appreciating the moment is a skill that all should learn and helps to not feel helpless and overwhelmed. The teacher may need to remind students that "appreciation" and developing a "spirit" of service and civic-mindedness is part of being connected to their community from "Learning Through Service," Kate McPherson, Project Service Leadership,

Let's Celebrate!

Whether a project goes as planned or not - ending on a positive note is recommended. Celebrations can take many forms - from doing a "happy dance" to shouting "hooray!" It's about the effort versus the results. During this stage, make sure to emphasize effort, dedication and the hard work rather than results. Some ways to celebrate could be:

- A class pizza or favorite food party perhaps with a river theme.
- Creating a slide show or album with photos of everyone participating.
- Having a special mentor, principal or community partner recognize their efforts.
- Have a reporter write a story or film part of the process or actions.
- Have a dedication ceremony with a ribbon cutting or unveiling.
- Create a time capsule with river messages and mementos for the future.

RIVEROLOGY

Evaluating Student Drawings

The analysis process attempts to get an understanding of the "meaning expressed" in the student's drawings. It's about what students are trying to share with you - it's a language. It's not about drawing (Alerby and Bergmark, 2012).

Steps to Evaluate Student Drawings

Step 1: **Create a template** with what you want to know and measure. Include a pre– column (before sharing information and stories and a post– column after sharing.

Step 2: **Implement the activity.**

Step 3: **Fill in the evaluation sheet** while reviewing the drawings. I recommend hard copies versus an electronic spreadsheet. You may want to attach each sheet to the drawing. This is handy if you are not asking students to include their names.

Step 4: **Look for differences** in pre– and post- drawings.

Step 5: **Create a mind map while evaluating the two drawings**, Draw a circle of a trending theme or pattern and then draw lines from it with students ideas and symbols.

Step 6: **Tally results.**

Step 7: **Formulate themes of meaning by analyzing the tally sheet results and the mind mapping.** In other words, what did you interpret as meaning - what were the students imagining, wondering about and sharing with you? Write a summary.

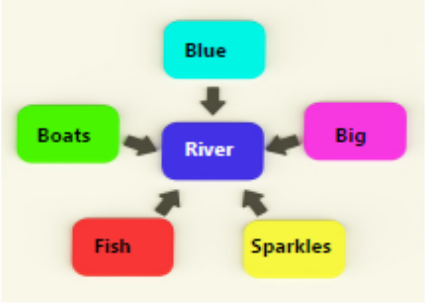
Create a 2-column template that reflects what you want to know and the criteria you want to measure.

Student inquiry question: *"What do you know about your river?"*

Potential questions to consider for evaluation of student work:

- **What percentage of drawings depicted a polluted river with marine debris** versus a river without debris?
- **What percentage of drawings included key features representing solutions** or stewardship (wetlands, trash can/cleanup, trees, volunteering, messages/signs, and appreciation/recreation/celebration, other)?
- **What percentage of drawings included a mental map of the river** looking like a tree limb with branches?
- What percentage of drawings included **local landmarks** (home, school, bridges, buses, maritime vessels, etc.)?

Click here Creating a Mind Map in Word



This is an example of a Mind Map.

Example Evaluation Template

The template below is an example created for the RIVEROLOGY Lesson 2: *What Do You Know About Your River?* Before creating the template, you would decide what you want to know by the end of the activity. You would then create criteria that you can measure. The teacher completes this template for each students pre– and post– drawings. For research purposes, you may consider leaving off students names and evaluating the entire class as a whole.

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
In the drawing was the river depicted as polluted with marine debris?			In the drawing was the river depicted as polluted with marine debris?		
In the drawing were wildlife harmed due to pollution?			In the drawing were wildlife harmed due to pollution?		
In the drawing were stewardship actions or key items that help a river with marine debris included?			In the drawing were stewardship actions or key items that help a river with marine debris included?		
Stewardship actions (litter clean ups, volunteering)			Stewardship actions (litter clean ups, volunteering)		
Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?			Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?		

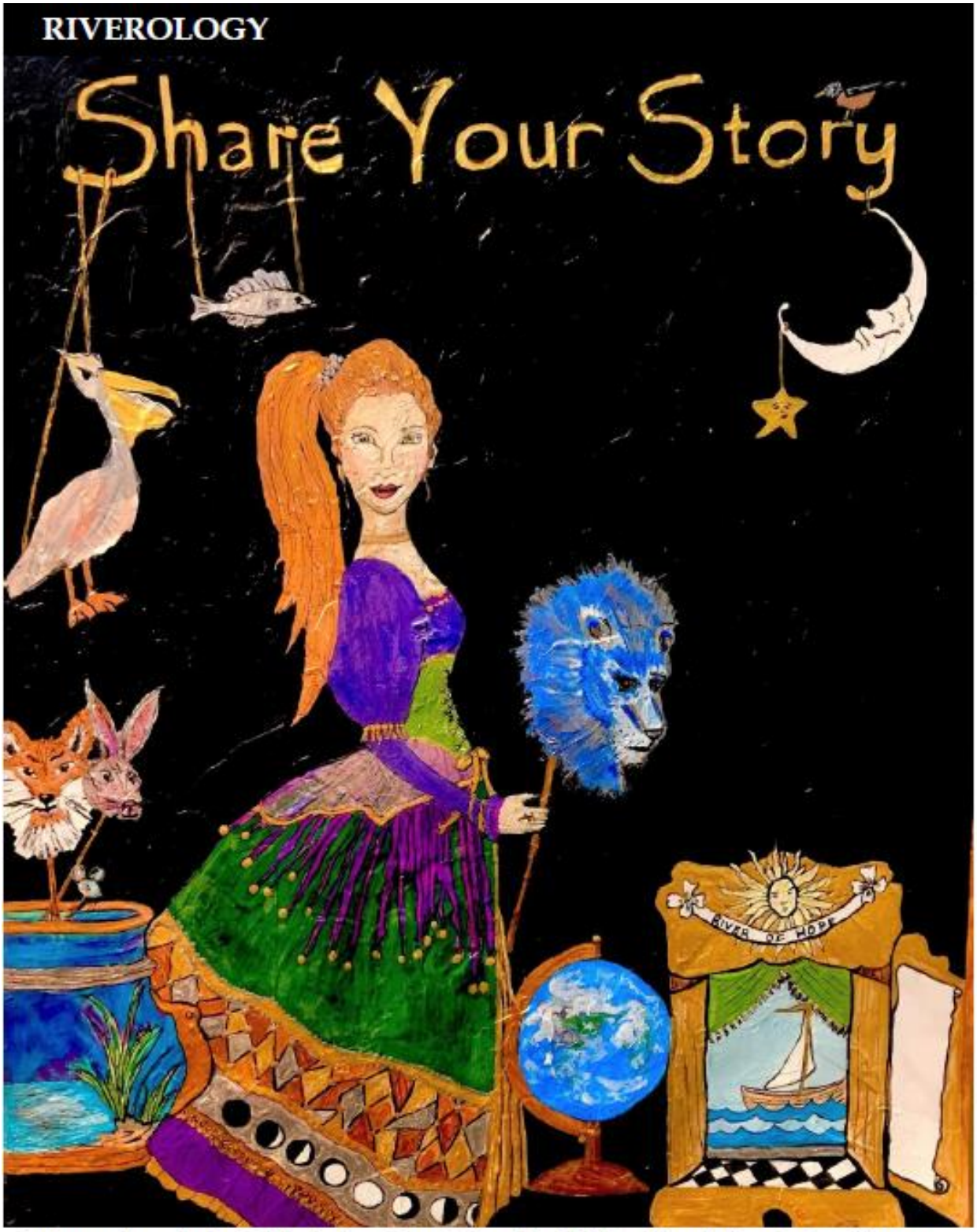
Right ~ Pre-drawing depicting a river with animals and trees.

Far Right ~ Post-drawing a mental map of a river with branches, wetlands, litter and newly planted trees.

Note ~ Providing students an opportunity to explain their drawings is essential for interpretation and decreases misinterpretation.

Pre-

Post-



Self-portrait rendering, Robin Dunbar. Commissioned by Old Dominion University Perry Library.

Storytelling Tips

Storytelling can help reveal information for students to visualize as if they were watching a movie (Gershon and Page).

- **Immerse your audience in a story**. Every word, prop and image should help create a clear mental image -a mental movie.
- **Visuals and props should supplement**, not repeat what you said. Include maps, artifacts, photos, a jar of river water, items from nature and consider wearing a costume or fun hat or scarf.
- **Include sensory details** to allow them to see, hear, feel, and smell the different stimuli in your story.
- **Tell a personal story.** Great stories include the quest for a treasure, and the voyage of a hero who comes back a changed person.
- **Create suspense with conflict and a plot.** Include predictions and hypothesis.
- **Bring characters to life.** Include rich details of characters in the minds of your listeners.
- **Show. Don't tell.** Try scene-by-scene construction of events with dialogue instead of narration.
- **Build up to S.T.A.R. moment.** Something They Will Always Remember.. The best stories are the ones that are shared.
- **End with a positive takeaway.** As spark of wisdom and an answer to what was the unknown is always great.

"I believed then, as I do now, in the goodness of the published word: it seemed to contain an essential goodness, like the smell of leaf mold." – E.B. White (Goodreads.com)

Robin Dunbar, *Balance*, Acrylics on linen, 2016.

RIVEROLOGY Lesson 1

What Does Earth Look Like?

Robin Dunbar,
Earth, 2021, Acrylic

THE STARTING POINT

Visualizing Earth

This first activity should be viewed as a starting point to see what emerges from youth's thoughts when reflecting about Earth. The goal is to interpret the meaning of children's thoughts.

Education professor Dr. Eva Alerby, University of Technology in Sweden argues, "How children think, feel, experience, hope, believe, act, dream and fear are all elements in this world. If we give them the opportunity to think and reflect—drawings can help them express their thoughts."

INQUIRE	**Begin by asking, *"What does Earth look like?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision** our home planet. Include a reading prompt such as the description of Earth below. *The earth looks like a deep blue glass marble floating in an inky black sky with the sunlight reflecting off the ocean. There are no strings holding it. Green and warm brown hues can be seen with bold streaks white from clouds, but also from the ice sheets at the poles.* 
DRAW	**Supplies:** Paper and coloring tools—crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies** to create their vision of what they are thinking. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete a pre– drawing.**
SHARE	Teachers choose how long to spend on this activity. 1.) **Students orally share what they were thinking** with their drawings. 2.) **Educators share the story** *"Why the Earth is Called the Blue Marble."* pg 38. 3.) **Teachers include this map activity:** a. Go to https://www.google.com/earth/ b. Click on LAUNCH EARTH and watch students excitement c. Type school address in SEARCH and explore, discover and have fun! d. Consider exploring NASA's Earth Observatory Global Maps 4.) **Watch: Videos:** National Geographic Earth 101 NASA 'Voice of Earth Share this book: The Blue Marble Best map of Earth Now 5.) **Students draw a post– drawing.**
ACT	**Students can take care of the planet** through art, music, actions and modeling behavior. Click here for NOAA's Top 10 Actions to help the ocean.
REFLECT	**Get outdoors and be immersed in nature.** Going outside shouldn't be a treat—it should be part of our daily lives. Take your students outdoors as often as you can and explore, discover and celebrate the Blue Planet.

RIVEROLOGY Lesson 1

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What does Earth look like?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings depicted the planet round, blue and green?

B. What percentage of drawings included the stars, moon, sun and clouds?

C. What percentage of drawings included people, trees, animals, buildings?

D. What percentage of the drawings included pollution?

E. What percentage of the drawings included continents, countries or states?

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What Does Earth Look Like?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
In the drawing was the earth depicted round?			In the drawing was the earth depicted round?		
In the drawing was the earth colored blue, green white or any combination?			In the drawing was the earth colored blue, green white or any combination?		
Did the drawing include the sun, moon and stars or any combination?			Did the drawing include the sun, moon and stars or any combination?		
Did the drawing include people?			Did the drawing include people?		
Did the drawing include plants and animals?			Did the drawing include plants and animals?		
Did the drawing include buildings?			Did the drawing include buildings?		
Did the drawing include pollution?			Did the drawing include pollution?		
Did the drawing include space craft?			Did the drawing include space craft?		
Did the drawing include a black sky?			Did the drawing include a black sky?		
Did the drawing include extreme weather?			Did the drawing include extreme weather?		
Did the drawing include continents, countries or states?			Did the drawing include conti-nents, countries or states?		
Did the drawing include a north and south pole?			Did the drawing include a north and south pole?		

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RIVEROLOGY Lesson 1

NASA: "Behold one of the more stunningly detailed images of the Earth yet created. This Blue Marble Earth montage, created from photographs taken by the VIIRS instrument on board the Suomi NPP satellite, shows many stunning details of our home planet." NASA images library: images-assets.nasa.gov/image/PIA18033/PIA18033~orig.jpg

Why is Earth called the Blue Marble?

"We are not the first to discover this, but we'd like to confirm....that the world is round." **NASA Astronaut Eugene Cernan, Commander, Apollo 17 Spacecraft.**

NASA AS17-134-20386 (7-19 Dec. 1972) Astronaut Eugene A. Cernan, Apollo 17 commander, is photographed next to the deployed United States flag during lunar surface extravehicular activity (EVA) at the Taurus-Littrow landing site. The highest part of the flag appears to point toward our planet Earth in the distant background. This picture was taken by scientist-astronaut Harrison H. Schmitt, lunar module pilot. While astronauts Cernan and Schmitt descended in the Lunar Module (LM) to explore the moon, astronaut Ronald E. Evans, command module pilot, remained with the Command and Service Modules (CSM) in lunar orbit. Click here for resource.

The iconic NASA photo was nicknamed, "The Blue Marble," and became more famous than the mission for being one of the most reproduced and recognizable photos. The photo was taken at an altitude of 28,000 miles and the sun was behind the spacecraft resulting in a fully lit Earth. They were traveling 20,000 miles an hour and there is a narrow time available to capture a fully lit earth. Although astronaut Schmitt claims he took the photo, all three Apollo 17 crew are given credit since they were all taking photos and NASA didn't capture who took the photo. There was only one camera that was not packed away and four pictures were taken a minute apart. The second photo was the sharpest and clearest. They did not realize the how famous it would be and didn't say anything to Mission Control about taking the picture. After the mission Mr. Underwood, a film technician, processed the mission's film in a NASA lab and shared the photo. Many credit this photo as changing the way people think about our planet and it was the first NASA crew to include a scientist—geologist Harrison Schmitt—and this help set the precedent for research. The photo also show a world without national borders and it's a reminder we are all neighbors. The 'Blue Marble' photo became the symbol of the environmental movement, Earth Day in 1970.

RIVEROLOGY Lesson 2

What Do You Know About Your River?

Small inlet of the Western Branch of the Elizabeth River, Portsmouth, Virginia.

INQUIRE	**Begin by asking, *"What do you know about your river?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision their river.** Consider reading this prompt about a river. *My river looks like .....* *My river smells like .....* *My river sounds like .....* *My river feels like .....* *My river includes .....* *This is what I know about my river .....*
DRAW	**Supplies:** Paper and coloring tools—crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes **1.) Students choose their art supplies** to create the vision of what they are thinking and envisioning. **2.) Remind students this activity is about using art to share what they are thinking**, imagining and envisioning—not great art. **3.) Students complete the pre-drawing**
SHARE	**1.) Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. **2.) Educators share the story** *About Rivers* of page 12 . **3.) Create a Story Map using ArcGIS.** See page 42. Educators can also choose to use the ArcGIS Elizabeth River Story Map. **4.) Additional resources:** Videos: Estuaries (The Elizabeth River is an estuary) NOAA (Resources and Videos National Geographic River Education **5.) Students draw a post– drawing.**
ACT	**Students engage in river stewardship** and help restore wetlands, do litter clean ups, install trash bins, recycle, plant trees, celebrate and enjoy their river. Coastal Stewardship Bay Stewardship Wild Rivers Watersheds Estuaries
REFLECT	Think about what you now know about your home river and how you can continue to help protect and restore it. Think about what you can do.

RIVEROLOGY Lesson 2

Measuring & Mapping

What to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What do you know about your river?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings depicted a polluted river with marine debris versus a river without marine debris?

B. What percentage of drawings include key features representing solutions or stewardship that would improve marine debris and litter challenges? Solutions and stewardship examples includes: wetlands, trash can/cleanup, trees, volunteering, messages/signs, and appreciation/ recreation/celebration, other?

C. What percentage of drawings include a mental map of the river looking like a tree limb with branches or showing a river with bends or going downhill, etc.

The template should then reflect what criteria you will look for in the students pre– and post drawings.

What to Show

Next create a story that provides info. you would like to see in the students post drawings. Consider creating a Story Map.

Create an ArcGIS Story Map

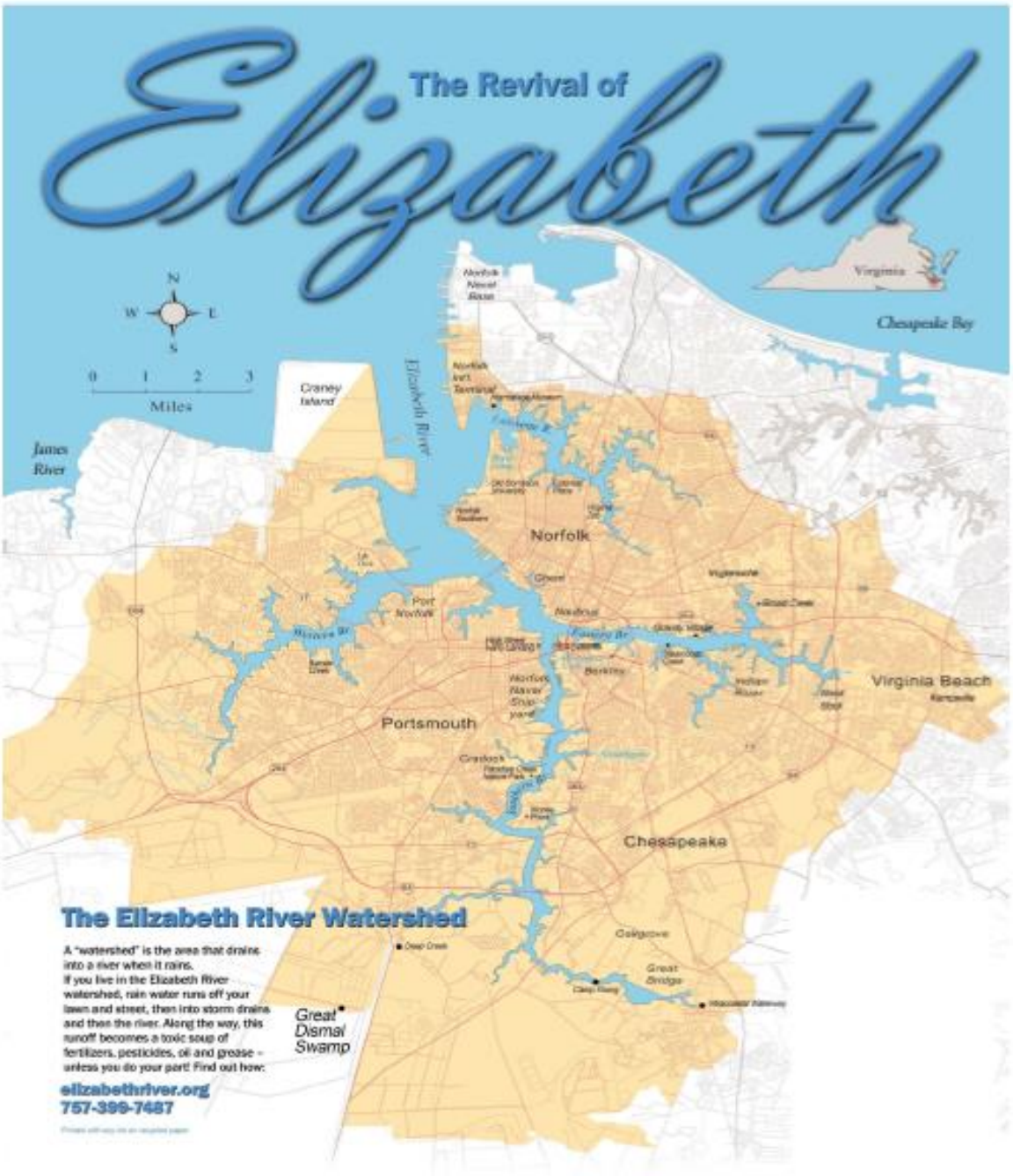
1. **Go to Google Chrome** and type "story maps for ArcGIS. You may need to create an account or sign in.
2. **Click + "New Story from Scratch"**
3. **Create a "Title"**
4. **Then click "⊕ Add"** to attach an image, map, video, audio or slide show.
5. **Create a 10-minute story map** that is a brief "Overview" of the river and include items to enrich the students drawings, complements the inquiry question and reflects what you are measuring such as: geography of the river, landmarks, state of health/challenges, wetland/tree canopy, wildlife, recreation and aerial of the river. Resources: Local river organizations, Google Chrome & maps, World Atlas Living Atlas ESRI, National Geographic Library of Congress Maps, Google Earth, USGS Maps
6. **Preview your Story Map** and make sure the information you included would help answer what you are measuring.
7. **Include sources** at end or throughout.
8. **Publish** and choose option(s) to share.

What do you know about your river?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
In the drawing was the river depicted as polluted with marine debris?			In the drawing was the river depicted as polluted with marine debris?		
In the drawing were wildlife harmed due to pollution?			In the drawing were wildlife harmed due to pollution?		
In the drawing were steward-ship actions or key items that help a river with marine debris included?			In the drawing were steward-ship actions or key items that help a river with marine debris included?		
Stewardship actions (litter clean ups, volunteering)			Stewardship actions (litter clean ups, volunteering)		
Wetlands			Wetlands		
Trash cans			Trash cans		
Trees			Trees		
Messages or signs			Messages or signs		
Celebration			Celebration		
Recreation			Recreation		
Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?			Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?		
Did the drawing include local landmarks (home, school, bridges, buses, maritime ves-sels, etc.)?			Did the drawing include local landmarks (home, school, bridges, buses, maritime ves-sels, etc.)?		

RIVEROLOGY Lesson 3

What's a Bird's View of Your River?



INQUIRY	Begin by asking, ***"What's a bird's view of your river?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision their river as if they are a bird flying in the sky and looking down at the river.** Consider reading this prompt: *Even the birds trust the breeze .....to take them high over the trees. High above the river they fly..... Way, way, up, up, up in the sky.*
DRAW	**Supplies:** Paper and coloring tools—crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	**1.) Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. **2.) Educators provide a map of the river to every student** or utilize computers to view river maps. **Consider locating local maps** at one of these locations: Local river organizations - Google Chrome & maps, World Atlas, Living Atlas with ESRI, National Geographic, Library of Congress Maps, Google Earth, USGS Maps **3.) Have a dialogue with the students** asking them what shape is the river? How many branches does it have? How many cities does it run through? How wide and long is it? Depending on the age, consider including landmarks, compass rose, legends and keys. You could also compare older maps of the river to newer maps and discuss how they have changed. **4.) Students draw a post– drawing.**
ACT	**Learn about your river's birds** and what they need to be healthy including food, shelter and habitat. Reduce litter and marine debris and learn ways to reduce bird injuries from reflective windows and other man-made items. Visit All About Birds, Bird Friendly Homes and Birds & Pollution
REFLECT	**Think about what you know now** about your home river and birds how you can continue to help. Think about what you can do.

RIVEROLOGY Lesson 3

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What's a bird's view of your river?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings show a river with branches?

B. What percentage of drawings show habitat and shelter such as trees and wetlands?

C. What percentage of drawings include birds?

D. What percentage of drawings show landmarks such as houses, bridges, buildings?

E. What percentage of drawings include stewardship actions that help birds?

F. What percentage of drawings include litter and marine debris?

These Elizabeth River birds were injured by fishing gear and rescued by a local rehabilitator volunteer group called Nature's Nanny Wildlife Rehabilitation.

What's a Bird's View of Your River?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
In the drawing was the river depicted as polluted with marine debris?			In the drawing was the river depicted as polluted with marine debris?		
In the drawings were birds included?			In the drawings were birds included?		
In the drawing were birds harmed due to pollution?			In the drawing were birds harmed due to pollution?		
In the drawing were habitat for birds included like trees and wetlands?			In the drawing were habitat for birds included like trees and wetlands?		
Litter Cleanups			Litter Cleanups		
Wetlands			Wetlands		
Trash cans			Trash cans		
Planting Trees			Planting Trees		
Messages or Signs			Messages or Signs		
Celebration			Celebration		
Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?			Did the drawing include a mental map of the river looking like a tree limb with branches or the river's shape?		
Did the drawing include local landmarks (home, school, bridges, buses, maritime vessels, etc.)?			Did the drawing include local landmarks (home, school, bridges, buses, maritime vessels, etc.)?		

RIVEROLOGY Lesson 4

What's on the Bottom of the River?

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INQUIRY	Begin by asking, ***"What's on the bottom of the river?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision what the bottom of their river might look like.** Consider reading this prompt: *The pelican dives very deep* *To catch a fish to eat and keep* *Way, way to the river bottom he goes* *What is down there—no one knows.*
DRAW	**Supplies:** Paper and coloring tools- crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	1.) **Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. 2.) **Educators create a story** about items that may end up on the bottom of the river due to improper disposal, extreme weather, runoff and storm water outfalls. Consider including river users, population, watershed and buoyancy. If using the Elizabeth River, the following article is recommended to include: *What's on the Bottom of the Elizabeth River* and watch NOAA's *Where Does Marine Debris Come From*? Project Aware and *What are Watersheds?* 3.) **Teachers resources:** a. **Watersheds:** https://www.google.com/earth/ EPA's to find your watershed address NOAA Watershed b. **Maps:** US Population Map Elementary: Census Population for Kids Middle: Census Population for Kids High: Census Population for Kids Virginia Census Map. To create an ArcGIS story map visit page 42. c. **Stormwater:** NOAA Stormwater Systems d. **Buoyancy:** Watch video on buoyancy for elementary kids. e. **Marine Debris:** National Geo Derelict Vessels Ghost Crab Pots 4.) **Students draw a post– drawing.**
ACT	Students learn their watershed address and how their river is utilized by the community. Learn your rivers issues and complete EPA's Watershed Academy.
REFLECT	**Think about what you know now about your watershed** and home river and how you can help protect and restore it. Think about what you can do.

RIVEROLOGY Lesson 4

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What's on the bottom of the river?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings show a cross section of the river (surface, column and benthos (bottom of the river) ?
B. What percentage of drawings show animals in the river?
C. What percentage of drawings include marine debris and litter?
D. What percentage of drawings show vessels?
E. What percentage of drawings include fisherman or maritime workers?
F. What percentage of drawings include animals injured?
G. What percentage of drawings include storm water drains and/or outfalls?
H. What percentage of drawings include fishing gear such as nets, ghost pots and fishing line?
I. What percentage of drawings show people removing the marine debris?
J. What percentage of drawings show the river as healthy and free of marine debris?
K. Did the drawing include wetlands and trees?
L. Did the drawing include trash bins or recycling receptacles?

Students can recycle water bottles, fill with river water to learn what items float, sink or dissolve and perform bottle biology experiments. This bottle has polystyrene (Styrofoam) small white balls, floating in it along with a small metal fish bead that sunk to the bottom.

What's on the Bottom of the River?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
Did the drawing show a cross section of the river (surface, column and benthos (bottom of the river)?			Did the drawing show a cross section of the river (surface, column and benthos (bottom of the river)?		
Did the drawing include animals in the river?			Did the drawing include animals in the river?		
Did the drawing include litter and marine debris?			Did the drawing include litter and marine debris?		
Did the drawing include vessels?			Did the drawing include vessels?		
Did the drawing include fisherman and maritime workers?			Did the drawing include fisherman and maritime work-ers?		
Did the drawing include injured animals?			Did the drawing include injured animals?		
Did the drawing include stormwater drains and outfalls?			Did the drawing include stormwater drains and outfalls?		
Did the drawing include fishing gear, nets, fishing line, crab pots?			Did the drawing include fishing gear, nets, fishing line, crab pots?		
Did the drawing show people removing the debris?			Did the drawing show people removing the debris?		
Did the drawing show a healthy river free of marine debris?			Did the drawing show a healthy river free of marine debris?		
Did the drawing include trash bins?			Did the drawing include trash bins?		
Did the drawing include wetlands and trees?			Did the drawing include wetlands and trees?		

RIVEROLOGY Lesson 5

How Does Pollution Get in the River?

INQUIRY	Begin by asking, ***"How does pollution get in the river?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision what the bottom of their river might look like.** Consider reading this prompt: *What is drifting?* *What is sinking?* *What is sifting?* *What are we thinking?*
DRAW	**Supplies:** Paper and coloring tools- crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	1.) **Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. 2.) **Educators create a story** that focuses on learning the top kinds of litter volunteers find and how marine debris gets in bodies of water. Consider sharing the global challenge of marine debris and litter that is land and water-based. Begin by watching NOAA's Trash Talk video, 5 Gyres and National Geographic *How to Keep Plastic Out of the Ocean* If using the Elizabeth River: Clean Virginia Waterways, VA Marine Reduction Plan, Ask HRGREEN, TIME, Top 20, VA Dept. of Transportation, Department of Environmental Quality, and Litter Free Virginia are recommended. 3.) **Maps:** NOAA Marine Debris Map and explore your river by using ArcGIS or Google Maps and have a dialogue on possible ways litter accumulates. To create an ArcGIS story map visit page 42. 4.) **Resources:** Ocean Conservancy, Balloon Litter, Keep America Beautiful, US EPA Strategy, Keep it Beachy Clean and Ocean Project Blue. 5.) **Students draw a post– drawing.**
ACT	Students participate in cleanup events such as World Ocean Day in June. To learn more watch Global Underwater Explorers Cleanup Event (Video) or an eco-film such as *Smog of the Sea*. Watch this to learn how to GO GREEN at home.
REFLECT	**Think about what you know now about how pollution gets in your home river** and how you can help protect and restore it. Think what you can do.

RIVEROLOGY Lesson 5

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: How does pollution get in the river?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings show a healthy river free of litter and marine debris?

B. What percentage of drawings show animals harmed by litter or marine debris?

C. What percentage of drawings show ways litter is getting in the river?

D. What percentage of drawings show people helping cleanup the river?

E. What percentage of drawings show healthy shorelines with wetlands, plants and trees?

F. What percentage of drawings show trash bins, litter receptacles (recycling), innovations?

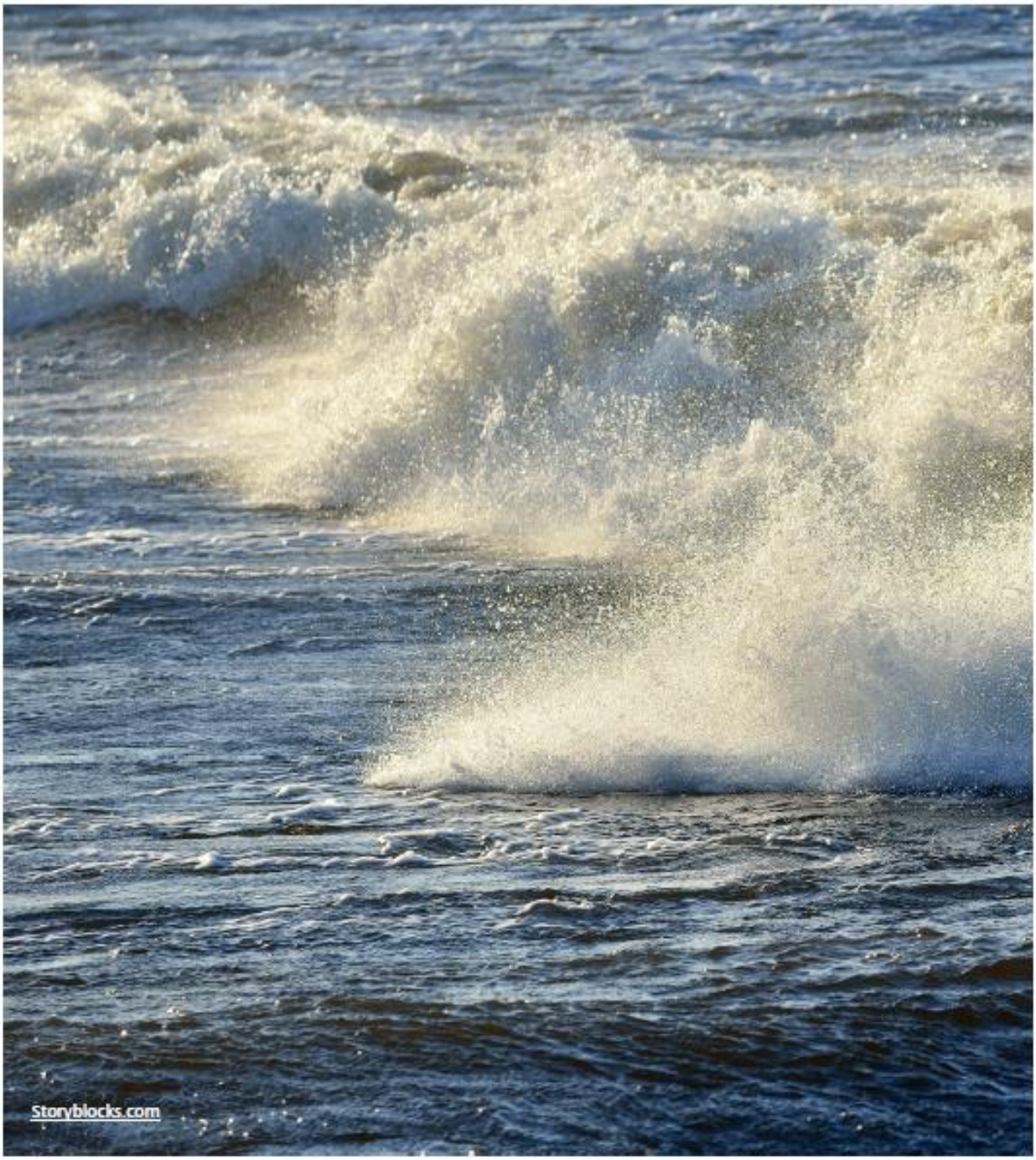
Student marine debris/litter curriculum includes: National Geographic *A Legacy of Litter*, *Marine Debris* (Middle School) and *Marine Debris* (Elementary) and NOAA's *Turning the Tide on Trash*.

How Does Pollution Get in the River?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
Did the drawing show a healthy river free of litter and marine debris?			Did the drawing show a healthy river free of litter and marine debris?		
Did the drawing show animals harmed by litter or marine debris?			Did the drawing show animals harmed by litter or marine debris?		
Did the drawing show ways litter and marine debris are getting in the river?			Did the drawing show ways litter and marine debris are getting in the river?		
Did the drawing show people participating in stewardship to clean up the river?			Did the drawing show people participating in stewardship to clean up the river?		
Did the drawing show healthy shorelines with wetlands, plants and trees?			Did the drawing show healthy shorelines with wetlands, plants and trees?		
Did the drawing show trash bins, litter receptacles (recycling) and/or innovations?			Did the drawing show trash bins, litter receptacles (recycling) and/or innovations?		
Did the drawing show just land based litter?			Did the drawing show just land based litter?		
Did the drawing show just water based litter?			Did the drawing show just water based litter?		
Did the drawing show marine debris only on the surface?			Did the drawing show marine debris only on the surface?		
Did the drawing show marine debris only on the river bottom?			Did the drawing show marine debris only on the river bottom?		
Did the drawing show education signs about littering?			Did the drawing show education signs about littering?		

RIVEROLOGY Lesson 6

What Does the River Look Like After a Storm?



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INQUIRY	Begin by asking, ***"What does the river look like after a storm?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision what the river looks like after a storm.** Consider reading this prompt: *The white clouds build to grey* *The wind begins to blow* *The river water starts to build* *A steady choppy flow*
DRAW	**Supplies:** Paper and coloring tools- crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	1.) **Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. 2.) **Educators create a story** on how river's are impacted by storms and extreme weather. This is a great activity to build a story with the students since they all have experiences with stormy weather. Consider creating a mind map together with "river storm" in the middle. Then ask the students to share what the river may look like after a storm. Then share impacts storms may have on rivers that includes: debris blown or washed into the river from land, storm drains, trees, maritime vessels, construction sites, trash bins, yards, streets, parking lots, etc. Also discuss how habitat can be impacted, flood waters increase and sediment is stirred up creating poor turbidity. 3.) **Maps:** NOAA River Observations, NOAA National Weather Service, National Hurricane Center, and NOAA Interactive Flood Map. 4.) **Resources:** Weather for Kids, National Geographic Extreme Weather *How Storms Impact Rivers*, *Rivers Rise After Hurricanes*, *Watch Storm Debris* 5.) **Students draw a post– drawing.**
ACT	Learn how storms impact your home river. Help secure items before storms in yards, at home, schools and businesses and help with cleanups.
REFLECT	Think about what you know now about your home river and how you can continue to help protect and restore it. Think about what you can do.

RIVEROLOGY Lesson 6

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What does the river look like after a storm?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings show plants and animals impacted by a storm in some way such as loss of habitat?

B. What percentage of drawings depict a calm river with flood waters, litter and debris, wind damage, etc?

C. What percentage of drawings depict a river experiencing a storm (rain, wind, choppy water, etc.)?

D. What percentage of drawings show people cleaning up a river after a storm?

E. What percentage of drawings show maritime vessels in the river or damaged after the storm?

F. What percentage of drawings show rain water carrying runoff into the river through storm drains, parking lots and streets?

Storm water pouring out of an outfall drain into the Elizabeth River during a rain event.

What Does the River Look Like After a Storm?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
Did the drawing show plants and animals impacted by a storm in some way such as loss of habitat?			Did the drawing show plants and animals impacted by a storm in some way such as loss of habitat?		
Did the drawing depict a calm river with flood waters, litter and debris, wind damage, etc?			Did the drawing depict a calm river with flood waters, litter and debris, wind damage, etc?		
Did the drawing depict a river experiencing a storm (rain, wind, choppy water, etc.)?			Did the drawing depict a river experiencing a storm (rain, wind, choppy water, etc.)?		
Did the drawing show people cleaning up a river after a storm?			Did the drawing show people cleaning up a river after a storm?		
Did the drawing show maritime vessels in the river or damaged after the storm?			Did the drawing show maritime vessels in the river or damaged after the storm?		
Did the drawing show rain water carrying runoff into the river through storm drains, parking lots and streets?			Did the drawing show rain water carrying runoff into the river through storm drains, parking lots and streets?		

RIVEROLOGY Lesson 7

What Does Sea Level Rise Look Like?

INQUIRY	Begin by asking, ***"What does sea level rise look like?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision what sea level rise might look like.** Consider reading this prompt: *The river water rises up* *The river water goes down* *The yards and streets flood* *All over the river town*
DRAW	**Supplies:** Paper and coloring tools- crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	1.) **Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. 2.) **Educators create a story** on how river's are impacted by flood water and rising seas. Focus on how a river and a river community is impacted by flooding, how habitat could be lost (flooded wetlands), and the water quality impaired (runoff, salinity, turbidity, etc). Discuss what it means to be resilient, prepared and able to adapt. Educators should begin by reading *NOAA's Story Map of Coastal Flooding* that includes the Elizabeth River and watching NOAA *"What's Sea Level Rise"* video. NASA also has great activities and information including *"What's Causing Sea Level Rise?"* , *"Graphing Sea Level Rise"* and EPA's *"Sea Level on the Rise"*. 3.) **Maps:** Utilize flood and storm surge maps to demonstrate how flood waters can impact river shore lines, wetlands, uplands, etc. NOAA Flood Map National Weather Service (Safety before, during and after floods) USGS Flood Map Tool FEMA Flood Maps Learn how to use NOAA's Sea Level Rise Viewer Tool on page 71. 4.) **Students draw a post– drawing.**
ACT	Learn how flooding can impact your home river and ways you can help. Sea Level Rise Stewardship Actions *How to Reduce Your Carbon Footprint*
REFLECT	Think about what you know now about how your home river is impacted by flood waters and think about what you can do.

RIVEROLOGY Lesson 7

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What does sea level rise look like?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings show plants and animals impacted by flood waters in some way such as loss of habitat?

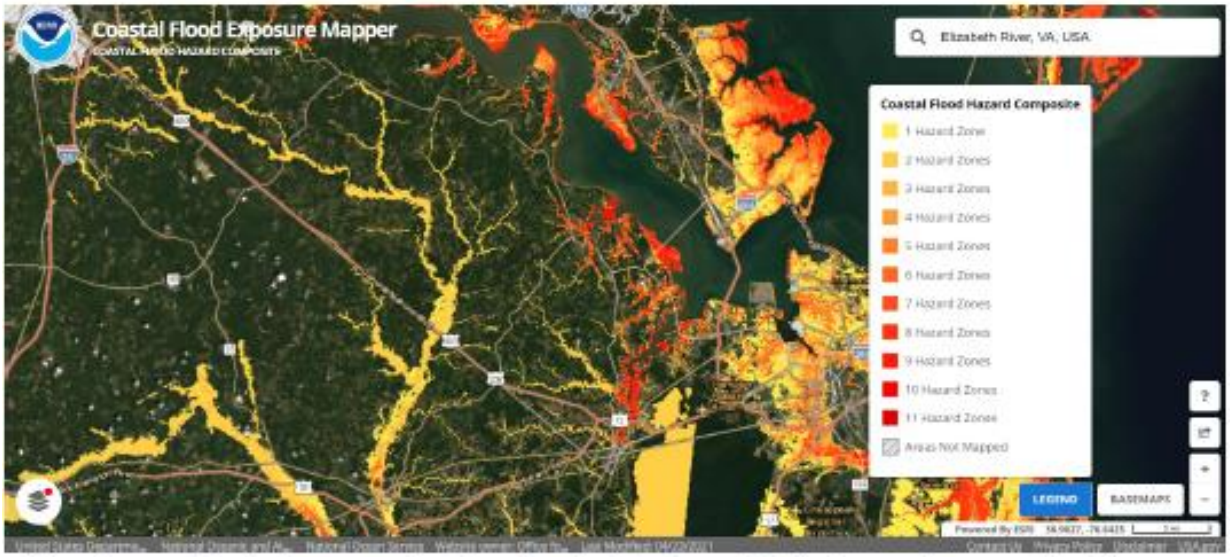
B. What percentage of drawings depict a river experiencing sea level rise with high tides?

C. What percentage of drawings depict a river community experiencing flood waters?

D. What percentage of drawings show rain gardens, rain barrels, wetlands and trees that can help absorb flood waters?

E. What percentage of drawings show people impacted by flood waters?

F. What percentage of drawings show flood waters as runoff and traveling to the river through storm drains, parking lots and streets?



Educators and students can explore how flood waters impact their river and community with National Oceanic and Atmospheric Administration's Coastal Flood Exposure Mapper.

What Does Sea Level Rise Look Like?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
Did the drawing show plants and animals impacted by flood waters in some way such as loss of habitat?			Did the drawing show plants and animals impacted by flood waters in some way such as loss of habitat?		
Did the drawing show a river experiencing sea level rise with high tides?			Did the drawing show a river experiencing sea level rise with high tides?		
Did the drawing show a river community experiencing flood waters? (streets, yards, homes flooded)			Did the drawing show a river community experiencing flood waters? (streets, yards, homes flooded)		
Did the drawing show ways to capture rain and flood water? (rain gardens, rain barrels, wetlands and trees can help absorb flood waters)			Did the drawing show ways to capture rain and flood water? (rain gardens, rain barrels, wetlands and trees can help absorb flood waters)		
Did the drawing show people impacted by flood waters? (people standing in water, stuck in a car, in a boat, kayak or canoe, etc)			Did the drawing show people impacted by flood waters? (people standing in water, stuck in a car, in a boat, kayak or canoe, etc)		
Did the drawing show flood waters as runoff and traveling to the river through storm drains, parking lots and streets?			Did the drawing show flood waters as runoff and traveling to the river through storm drains, parking lots and streets?		

RIVEROLOGY Lesson 8

What Do the River Plants and Animals Look Like?

Storyblocks.com

INQUIRY	Begin by asking, ***"What do the river plants and animals look like?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision what the river's plants and animals look like.** Consider reading this prompt: *Animals love the river* *and plants do too.* *Some like the cool water* *and there are many and few.*
DRAW	**Supplies:** Paper and coloring tools- crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	1.) **Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. 2.) **Educators create a story** on the different kinds of river animals and plants. Begin by learning the salinity of the river water that determines what kind of plants and animals live in or around the river. Share that some animals migrate and some may be native or invasive. Students will likely enjoy this activity about plants and animals, so find ways to make it fun! Begin by watching *River Ecosystems* Video and *What is Salinity?* If studying the Elizabeth River - go to Elizabeth River. 3.) **Resources:** National Geographic *Fresh Water Animals*, NOAA *Fisheries & Habitats*, Science Direct *River Ecosystems*, National Geo Kids *Animals* National Weather Salinity, USGS Saline Water 4.) **Maps:** There are interesting maps that show populations, migration, habitat and more. ArcGIS *Wild Animal Population* Interactive map to view US States Endangered Species, NASA Earth Observatory 5.) **Students draw a post– drawing.**
ACT	Learn how to protect plant and animals and conserve and restore their habitat and ecosystem. Consider volunteering to help wildlife rescuers and rehabilita-tors and restore native wetlands, plants and trees. World Wildlife Audubon Nature Conservancy Oceana Conservation Int'l and Jane Goodall
REFLECT	Think about what you know now about your home river's animals and plants an and how you can help. Think about what you can do.

RIVEROLOGY Lesson 8

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What do river plants and animals look like?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings show plants and animals?

B. What percentage of drawings show only land based animals?

C. What percentage of drawings show only water based animals?

D. What percentage of drawings show people doing actions that help plants and animals?

E. What percentage of drawings show plants and animals impacted by pollution?

What Do River Plants and Animals Look Like?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
Did the drawing show plants and animals?			Did the drawing show plants and animals?		
Did the drawing show non-native plants and animals?			Did the drawing show non-native plants and animals?		
Did the drawing show only land-based animals?			Did the drawing show only land-based animals?		
Did the drawing show only water-based animals?			Did the drawing show only water-based animals?		
Did the drawing show people doing actions that help plants and animals?			Did the drawing show people doing actions that help plants and animals?		
Did the drawing show plants and/or animals impacted by pollution?			Did the drawing show plants and/or animals impacted by pollution?		
Did the drawing depict biodiversity with small to medium to large animals?			Did the drawing depict biodiversity with small to medium to large animals?		
Did the drawing show water-men and fisherman?			Did the drawing show water-men and fisherman?		

RIVEROLOGY Lesson 9

What Does a River Superhero Look Like and Do?

INQUIRY	Begin by asking, ***"What does a river superhero look like and do?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	**Students close their eyes and envision what a river superhero looks like and does.** Consider reading this prompt: *I can do it!* *This is my theme.* *Let's clean the river.* *I can lead a team.*
DRAW	**Supplies:** Paper and coloring tools- crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	1.) **Students orally share what they were thinking with drawings.** Teachers should make notes on the Evaluation Template. 2.) **Educators create a story** sharing how all ages can play a role in taking care of their home river. This should be an inspiring story that includes achievable things students can do. Actions should not be presented as a list of chores, but instead as way for youth to feel connected to nature and their community. Children understand that rivers, animals and plants need to be healthy. Adults can mentor youth on how they can help protect, nurture, and heal our waters. This activity is about inspiring and empowering all ages to envision themselves as helping our rivers and taking action. 3.) **Watch:** *Elizabeth River, VA*, Elizabeth River Oysters *Youth Projects for the Elizabeth River, VA*, Kids in Hawaii Take Action Against Plastic, *How We Will Rid the Ocean of Plastic Innovation*, Misson Blue, *Kids Take Action Again Ocean Plastic* *Kids Clean Elizabeth River in New Jersey* (different river) 4.) **Resources:** Marine Conservation Careers, Root and Shoots Projects, Jane Goodall Nature Conservancy Ask HRGreen American Rivers Bay 5.) **Students draw a post– drawing.**
ACT	Protect earth's waters and engage in stewardship and be a superhero! Planet Saving Superhero Superhero Challenge Fish & Wildlife Stewardship
REFLECT	Think about what you know now about your home river and how you can continue to help protect and restore it. Think about what you can do.

RIVEROLOGY Lesson 9

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What does a river superhero look like and do?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings show a river superhero that resembles themselves?

B. What percentage of drawings show more than one river superhero?

C. What percentage of drawings show a river superhero doing stewardship actions that could help the river?

D. What percentage of drawings show a river superhero doing stewardship that gets rid of a river challenge such as litter and marine debris, flooding, etc.

E. What percentage of drawings include a name of the river superhero?

F. What percentage of drawings show the river superhero's special talent or skills?

G. What percentage of drawings show a river superhero in the air? On the land? In the river?

A black latex rubber glove washes ashore from the Elizabeth River.

What Does a River Superhero Look Like and Do?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
Did the drawing show a river superhero that resembles themselves?			Did the drawing show a river superhero that resembles themselves?		
Did the drawing show more than one river superhero?			Did the drawing show more than one river superhero?		
Did the drawing show a river superhero doing actions that could help the river?			Did the drawing show a river superhero doing actions that could help the river?		
Did the drawing show a river superhero doing stewardship that gets rid of a river challenge such as litter and marine debris, flooding, etc.			Did the drawing show a river superhero doing stewardship that gets rid of a river challenge such as litter and marine debris, flooding, etc.		
Did the drawing show a name of the river superhero?			Did the drawing show a name of the river superhero?		
Did the drawing show the river superhero's special talent or skills?			Did the drawing show the river superhero's special talent or skills?		
Did the drawing show a river superhero in the air?			Did the drawing show a river superhero in the air?		
Did the drawing show a river superhero on the land ?			Did the drawing show a river superhero on the land ?		
Did the drawing show a river superhero or in river?			Did the drawing show a river superhero or in river?		

RIVEROLOGY Lesson 10

What Will Your River Look Like in the Future?

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INQUIRY	Begin by asking, ***"What Will Your River Look Like in the Future?"*** **REMINDER:** Create an Evaluation Template of what you would like to know and choose the criteria you would like to measure. See page 30.
VISUALIZE	Students close their eyes and envision what your home river will look like in 25 years. Will people have protected it?
DRAW	**Supplies:** Paper and coloring tools- crayons, markers, pastels, pencils, etc. **Activity:** 15-30 minutes 1.) **Students choose their art supplies to** create the vision of what they are thinking and envisioning. 2.) **Remind students this activity is about using art to share what they are thinking,** imagining and envisioning—not great art. 3.) **Students complete the pre-drawing.**
SHARE	1.) **Students orally share** what they were thinking and share their drawings. Teachers should make notes on the Evaluation Template. 2.) **Create a story** utilizing National Geographic and US Fish & Wildlife, to discuss the importance of conservation practices and developing a strategic plan. **Consider sharing with the students a river's strategic plan.** Most river organizations have a strategic plan like the Elizabeth River to address problems. **Highlight one problem like sea level rise in the Elizabeth River.** Talk about how to plan to be resilient and address sea level rise for the future of the Elizabeth River. 3.) **Consider including the Map Activity** that utilizes NOAA's Sea Level Rise Viewer Tool. See page 64. 4.) **VIDEO:** Watch short video about NASA and NOAA Satellite to help rivers in the future. After, provide time for students to ask questions. 5.) **Students draw a post– drawing.**
ACT	**Research local groups that are protecting and restoring your river** and ask for ways you can help. River Network
REFLECT	**Think about what you know now about your home river** and how to help protect, restore and celebrate it. Think about what you can do.

RIVEROLOGY Lesson 10

Measuring What You Want to Know

Before creating an activity, decide on what you want to measure. Review the inquiry question and then ask yourself, "At the end of this activity, what do I want to know?"

INQUIRY: What will your river look like in the future?

Potential questions to consider for evaluation of student work:

A. What percentage of drawings depicted a polluted river versus a healthy river?

B. What percentage of drawings include key features representing solutions or stewardship? Stewardship examples includes: tree plantings, restoring wetlands, cleanups, etc.

C. What percentage of drawings included life such as plants, animals and people?

D. What percentage of drawings included rising seas or extreme weather?

E. What percentage of drawings depicted a futuristic river with different modes of transportation, buildings, machines, robots, etc.?

The Bottle Nose Dolphin can be seen in the Elizabeth River.

What Will Your River Look Like in the Future?

	Yes	No			
Is the pre- drawing different from the post- drawing?					
PRE DRAWING	**Yes**	**No**	**POST DRAWING**	**Yes**	**No**
In the drawing was the river depicted as polluted?			In the drawing was the river depicted as polluted?		
In the drawing was the river depicted as health?			In the drawing was the river depicted as health?		
In the drawing were steward-ship actions or key items that help a river included?			In the drawing were steward-ship actions or key items that help a river included?		
Stewardship actions (litter clean ups, volunteering)			Stewardship actions (litter clean ups, volunteering)		
Wetlands			Wetlands		
Trash cans			Trash cans		
Trees			Trees		
Messages or signs			Messages or signs		
Was life depicted in the picture including plants, animals and humans?			Was life depicted in the pic-ture including plants, animals and humans?		
Was the river futuristic with robots, different modes of transportation, robots, machines, etc?			Was the river futuristic with robots, different modes of transportation, robots, machines, etc?		

RIVEROLOGY Lesson 10

Map Activity

Use NOAA's Sea Level Rise Viewer

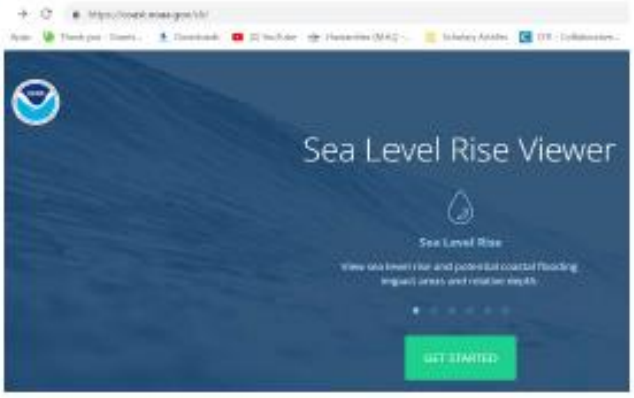
NOAA's Sea Level Rise Viewer

STEP 1

Teacher should watch this TUTORIAL (10-minutes) to familiarize themselves with this easy tool.
Then have students Watch NOAA and Elizabeth River Sea_Level Rise short video.

Go to **NOAA's Sea Level Rise Viewer**. https://coast.noaa.gov/slr/

Click **GET STARTED.**



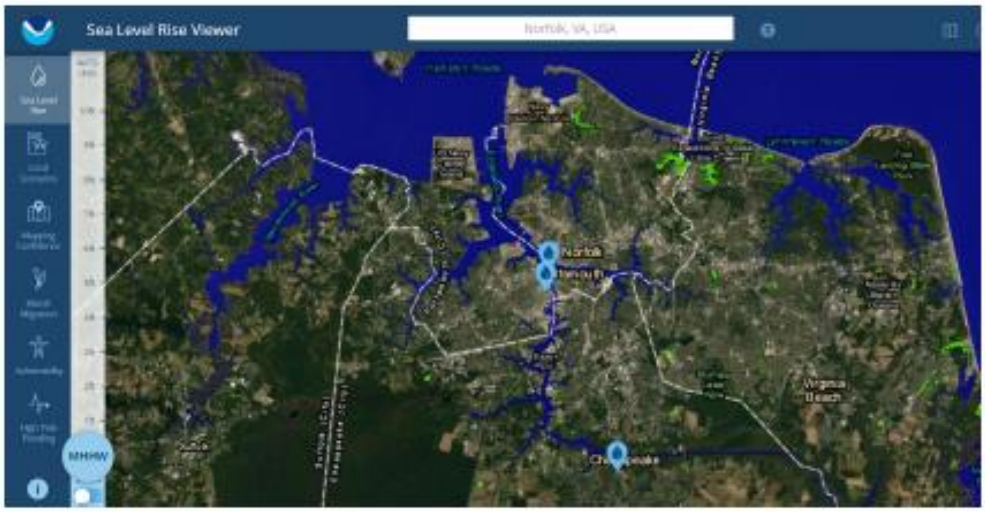
STEP 2

Type **Norfolk, VA** in the **SEARCH** box at top middle of the page.

Click on Norfolk, Virginia as an option and **click enter.**

STEP 3

Zoom closer into Norfolk and note what places are near the Elizabeth River. You should see shopping centers, a park, Harbor Park Baseball stadium, a hospital. streets, bridges, etc.



STEP 4

Click on the BLUE WATER DROP **Wisconsin Square.**

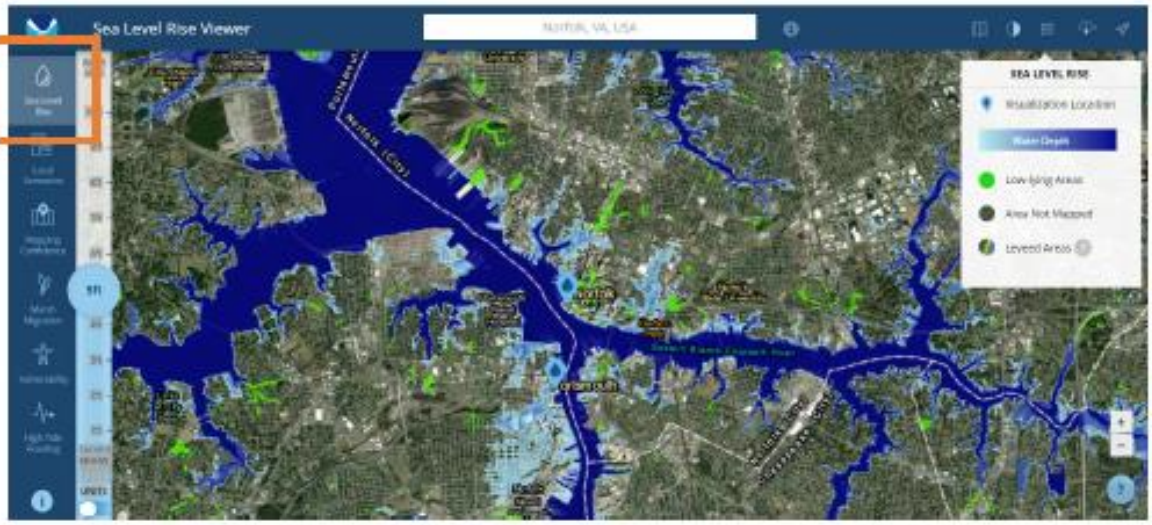
SEA LEVEL RISE option on the top left should be highlighted. See images below.

Slide the MHHW button at the bottom up to increase water level and have students note what happens to the statue. Talk about impacts of higher water. Mean Higher High Water (MHHW) is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. Click to learn about MHHW.

RIVEROLOGY Lesson 10

STEP 5

Click on LEGEND icon  at top right and share with students color meaning of the depths of water with sea level rise. Then **move to other BLUE WATER DROPS** and discuss impacts to the cities.



STEP 6

Click on VULNERABILITY and  **LEGEND .** Discuss high/low vulnerability throughout the cities. Discuss what landmarks are in those areas and how flood waters impact our communities.

STEP 7

Click on HIGH TIDE on the left side bar and the LEGEND and note what happens daily with the tides and flooding.

STEP 8

Click on BASE MAP **at the top right of the screen** and show

In a dark view how areas are impacted by flooding.

STEP 9

Click on MARSH MITIGATION on the left side bar and discuss habitat and wetland impacts with flood waters. Marshes provide essential benefits including slowing flood water (sponging), decreasing erosion and providing habitat and shelter for wildlife.

RIVEROLOGY

Vocabulary

benthic: relating to the ocean bottom.

best management pratices (BMPs): A method, activity, maintenance procedure, or other management practice ofr preventing or reducing the pollution resulting from an activity.

biodegradation: The process by which a substance or an object that came directly from a living thing is broken down, or decomposed, by living things (bacteria and invertebrates) and is turned back into a usable product.

biodiversity: Diverse forms of life on Earth.

bio-magnification: An increase in concentration of a pollutant from one link in a food chain to another.

buoyancy: The ability to float in water

combined sewer overflow: Pipes that carry a combination of sewage and stormwater are known as combined sewers.

data: A set of facts about a particular subject, shich can be analyzed to learn more about the subject.

debris: Discarded items; trash and litter; man-made materials and solid wastes that are released accidentally or intentionally in the environment.

degradable: Capable of being broken down into smaller pieces by natural forces.

derelict fishing gear: Fishing gear lost or abandoned at some point during use.

ecosystem: A natural community composed of biotic (living) creatures that live in connection with each other and abiotic (non-living) elements like sun soil and water.

entanglement: The looping of a piece of debris around part of an animal's body.

estuary: A body of water at the lower end of a river which is connected to the ocean and semi-enclosed by land.

food chain: a series of animals and plants, each depending on the next for food.

food web: A network of living things that depend on each other for food.

ghost fishing: Lost or discarded fishing gear, such as nets, traps, or fishing line, to continue to catch fish, shellfish or other marine life.

gyre: A circular pattern of currents in an ocean basin.

ingestion: the consumption of a piece of debris by an animal.

landfill: An engineered site for disposing of solid waste on land that is constructed to reduce any hazards to public health and safety.

litter: Trash, wastepaper, or garbage lying scattered about Litter is unwanted trash or garbage that is thrown out of vehicles or onto the ground by pedestrians.

marine debris: Persistent solid material manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment. NOAA

mechanical degradation: A physical interaction between ocean waves and plastic, in which rubbing, smashing, or grinding against the water and/or solid objects causes the plastic to break into smaller pieces

micro-plastics: Any piece of plastic smaller than 5 mm in the largest dimension.

mudflat: part of benthic zone exposed at low tide and comprised of extremely fine sediments.

municipal solid waste: garbage generated by households, businesses and includes yard trimmings.

non-degradable: Incapable of being broken down into simple compounds or components.

outfall pipe: discharges water and other materials into a receiving water body.

photodegradation: The process which a substance or object is broken down via sunlight.

point source pollution: Pollution from a defined, localized source such as a sewage outfall.

pollution: contamination of natural environment.

recycling: Converting waste into reusable material

runoff: precipitation that drains into a water body from the surface of the surrounding land.

sewage: Used water/water-carried solids from homes that flow in sewers to wastewater treatment plant.

solid waste: solid, semi-solid, liquid or gaseous materials discarded.

stormwater: Stormwater is rain that doesn't soak into the ground. Instead it flows from our roofs, over pavement, across bare soil and down the street.

3 R's: Reduce, Reuse, Recycle

water column: The conceptual layers of water from surface to bottom

watershed: An area of land where all of the water flows to a common point. A watershed is an area of land that drains to a common body of water such as a stream, river or lake.

RIVEROLOGY

Resources

Alliance for the Bay: www.Allianceforthebay.org

American Rivers https://www.americanrivers.org/conservation-resource/rivers-roads/

Bay Backpack https://www.baybackpack.com/

Chesapeake Bay Foundation https://www.cbf.org/about-cbf/our-mission/educate/

Clean Virginia Waterways https://marinedebris.noaa.gov/turning-tide-trash

Department of Game and Inland Fisheries https://dwr.virginia.gov/education/resources-for-teachers/

Elizabeth River Project Virtual Classroom https://elizabethriverprojec.wixsite.com/kids/virtual-classroom

Elizabeth River Project's Score Card 2020 https://elizabethriver.org/sites/default/files/ERP-State-of-the-River-2020.pdf

Environmental Protection Agency https://www.epa.gov/environmental-topics/water-topics#our-waters

Keep America Beautiful: https://kab.org/

Keep America Beautiful Executive Summary 2009 - National Litter Research Findings and Recommendations. https://kab.org/wp-content/uploads/2019/08/LitterinAmerica_ExecutiveSummary_Final_0.pdf

Marine Mega Fauna https://marinemegafauna.org/

NASA https://www.nasa.gov/stem/about.html

National Academy of Sciences https://www.nap.edu/read/11773/chapter/3

National Geographic Understanding Rivers https://www.nationalgeographic.org/article/understanding-rivers/?utm_source=BibblioRCM_Row **Geo-inquiries** https://www.nationalgeographic.org/education/programs/geo-inquiry/

Nature Conservancy https://www.nature.org/en-us/

NOAA

- **Marine Debris:** https://marinedebris.noaa.gov/activities-and-curricula
- ***An Educator's Guide to Marine Debris.*** https://marinedebris.noaa.gov/sites/default/files/NAMEPALearningGuideFinal_508.pdf
- **Estuaries:** https://www.fisheries.noaa.gov/national/habitat-conservation/estuary-habitat
- **Stewardship for Oceans:** https://oceanservice.noaa.gov/ocean/help-our-ocean.html
- ***NOAA's 2014 Report on the Entanglement of Marine Species in Marine Debris with an Emphasis on Species in the United States.*** https://repository.library.noaa.gov/view/noaa/21427

National Oceanic and Atmospheric Administration (NOAA): https://oceanservice.noaa.gov/hazards/marinedebris/

10 Ways to Reduce Plastic & Carbon – 10 easy ways you can be green at home.

Universal Waste Disposal Guidelines – Guidelines to trash, recycling, and compost.

Monthly plastic-free challenge – Kick the plastic habit.

North American Marine Environment Protection Association (NAMEPA) is an industry-led organization that works to educate seafarers, port communities and students about the need and strategies for protecting the marine environment. https://namepa.net/education/

Ocean Foundation: https://oceanfdn.org/plastic-ocean-pollution/

Oceana https://oceana.org/

Ocean Conservancy https://oceanconservancy.org/

Project Aware https://www.projectaware.org/

River Network https://www.rivernetwork.org/

Science Matters https://www.epa.gov/sciencematters

Stream to Sea Initiative: https://www.americancanoe.org/page/StreamtoSea

Terracycle: collaborates with local communities to offer innovative collection and recycling platforms for waste, with special emphasis on preventing plastic pollution from entering our oceans. The Foundation works with local government entities to install marine debris capture technology to intercept waste from rivers. https://www.terracycle.com/en-US/zero_waste_boxes

TREX.com 1.) One program is the Plastic Film Recycling Challenge Every year hundreds of schools across the nation compete to recycle the most plastic film. Trex will give awards to every school that participates. The challenge begins each year on America Recycles Day, November 15, and lasts until April 15. Trex will provide your school with promotional materials and three recycling bins. Winners - Earth Day. https://www.trex.com/recycling/recycling-programs/

United Nations: The Blueprint for Ocean and Coastal Sustainability. http://www.unesco.org/new/en/natural-sciences/ioc-oceans/focus-areas/rio-20-ocean/10-proposals-for-the-ocean/

World Wildlife Fund https://www.worldwildlife.org/initiatives/oceans

"Your Quick Guide to Community-Based Social Marketing,' https://www.sustainability.upenn.edu/sites/default/files/Guide%20to%20Community-Based%20Social%20Marketing.pdf

RIVEROLOGY

Mapping Resources

ArcGIS https://www.arcgis.com/index.html#

ArcGIS Story Maps https://storymaps.arcgis.com/stories

Esri.com https://www.esri.com/en-us/industries/education/schools/geoinquiries-collections

Google Earth https://www.google.com/earth/

Marine Debris Mapping Activity https://www.esri.com/content/dam/esrisites/en-us/media/pdf/9-marinedebris-apes-geoinquiry.pdf

National Geographic Map Maker https://mapmaker.nationalgeographic.org/

Students and teachers can benefit from including mind maps into activities. Creating a Mind Map in Word

Bibliography

RIVEROLOGY

Gomi, Takashi, Roy C. Sidle and John S. Richardson. "Understanding Processes and Downstream Linkages of Headwater Systems: Headwaters differ from downstream reaches by their close coupling to hillslope processes, more temporal and spatial variation, and their need for different means of protection from land use," *BioScience*, vol 52, Issue 10, October 2002, pp 905–916. https://doi.org/10.1641/0006-3568(2002)052[0905:UPADLO]2.0.CO;2

National Research Council. 2007. *River Science at the U.S. Geological Survey*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11773.

Teaching RIVEROLOGY

American Rivers https://www.americanrivers.org/rivers/discover-your-river/river-anatomy/

Visualize

Alerby, Eva. "A Way of Visualizing Children's and Young People's Thoughts about the Environment: A Study of Drawings." *Environmental Education Research*, vol. 6, no. 3, 2000.

Brooks, Margaret. "Drawing, Visualization and Young Children's Exploration of 'Big Ideas'", *International Journal of Science Education*, vol. 31, no. 3, 2009, pp 319-341.

Chen, Pearl and Diane McGrath. "Visualize, Visualize, Visualize: Designing Projects for Higher-Order Thinking," *Learning and Leading with Technology*, vol 32, no 4, 2004.

Gilbert, J.K. "*Visualization in Science Education.*" Dordrecht: Springer, 2005.

Draw

Alerby, Eva. "During the Break We Have Fun: A study concerning pupils' experience of school. Educational Research, 45(1), 2003, pp 17-28.

Alerby, Eva. "A Picture Tells More Than A Thousand Words: Drawings Used as Research Method." *Children's Images of Identity*, Sense Publishers, 2015, pp 15-25.

Merleau-Ponty, M. Signs. Illinois, IL: Northwestern University Press, 1995.

Van Manen, M. "Human science for an actions sensitive Pedagogy." *Researching Lived Experience*, London, State University of New York Press, 1990.

Vygotsky, L.S. *The Psychology of Art.* Cambridge MIT Press, 1990.

RIVEROLOGY Bibliography Continued

Act

Chapin, F.Stuart, Steward Pickett, Mary Power, Robert Jackson, David Carter and Clifford Duke. "Earth Stewardship: A Strategy for Social-Ecological Transformation to Reverse Planetary Degradation," J Environ Stud Sci, 2011, pp 44-53.

Kirby, Perpetua, et al. *Building a Culture of Participation*. The National Children's Bureau: Department for Education and Skills, 2003.

Evaluating River Knowledge

Alerby, E. and U. Bergmark. "What can an image tell? Challenges and benefits of using visual art as research method to voice lived experiences of students and teachers." *Journal of Arts and Humanities*, 2012, pp 95-104.

Creating a Mind Map in Word https://www.edrawsoft.com/mindmap/create-mind-map-on-microsoft-word.html

Storytelling Tips

Gershon, Nahum and Ward Page. "What Storytelling Can Do for Information Visualization," Communications of the ACM, vol 44, no 8, 2001, pp 31-37.

TED Talks Best Presenter Tips: https://visme.co/blog/7-storytelling-techniques-used-by-the-most-inspiring-ted-presenters/

White, E.B. Goodreads Quotes, https://www.goodreads.com/author/quotes/988142.E_B_White?page=14

Why is Earth Called the Blue Planet?

Nardo, Don. *The Blue Marble: How a Photograph Revealed Earth's Fragile Beauty*, Compass Point Books, 2014.

NASA: Apollo 17 Mission: Apollo 17 Mission image - station Lunar Module (LM),Flag,CDR,LRV, 12-7-1972. https://images.nasa.gov/details-as17-134-20386.

NASA The Blue Marble. https://www.nasa.gov/image-feature/the-blue-marble-the-view-from-apollo-17

NASA: *All About Earth,* https://spaceplace.nasa.gov/menu/earth/

National Geographic Kids: *Mission to Earth,* https://kids.nationalgeographic.com/explore/space/mission-to-earth/

NOAA: *Is the Earth Round?* ,https://oceanservice.noaa.gov/facts/earth-round.html

Teaching Youth About Rivers

https://www.britannica.com/science/river

https://whatsanswer.com/maps/all-water-flows-river-map-of-the-usa-1/

NOAA All Rivers Flow https://seagrant.whoi.edu/k-12/coast/worldofwater/

Inquiry

Meier, Daniel and Stephanie Sisk-Hilton. *Nature Education with Young Children, Integrating Inquiry and Practice*, Routledge, 2013. https://books.google.com/books?hl=en&lr=&id=jEE8m-wYiF4C&oi=fnd&pg=PP1&dq=young+children+inquiry&ots=YySFMbaRcy&sig=vqlVx4ecK7h4A2cwm-1E6oTohMU#v=onepage&q=young%20children%20inquiry&f=false

National Geo-Inquiry Process: https://www.nationalgeographic.org/education/programs/geo-inquiry/

Smith, Corinne Hosfeld. *Henry David Thoreau for Kids: His Life & Ideas with 21 Activities*, Chicago Review Press Inc., 2016.

Share

Banister, Fiona and Charly Ryan. "Developing Science concepts Through Story-Telling," *School Science Review*, September 2001, pp 75-83.

Bostrom, Agneta. "Narratives as Tools in Designing the School Chemistry Curriculum," Interchange, vol 39, 2008, pp 391-413.

Egan, K. "Teaching as story-telling," *London: University of Chicago Press*, 1989.

Gershon, Nahum and Ward Page. "What Storytelling Can Do or Information Visualization," *Communication of the ACM*, vol 44, no 8, August 2001, pp 31-37.

Huffaker, David. "Spinning Yarns Around the Digital Fire: Storytelling and Dialogue among Youth on the Internet," *Information Technology in Childhood Education Annual*, 2004, pp 63-75.

Svoboda, E. "The Power of Story," Online, 2015. https://aeon.co/essays/once-upon-a-time-how-stories-change-hearts-and-brains

Weber, S. "The Narrative Anecdote in Teacher Education," *Journal of Education for Teaching*, 1993, pp 71-82.

Reflect

Zemelman, S., Daniels, H., & Hyde, A. *Best Practice: New Standards for Teaching and Learning in America's School (3rd Edition)*, Portsmouth, NH: Heinemann, 2005.

APPENDIX B

HUMANITIES RESPONSIBLE CONDUCT TRAINING CERTIFICATE

CITI PROGRAM

Completion Date 14-Jan-2020
Expiration Date N/A
Record ID 34820174

This is to certify that:

Robin Dunbar

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Humanities Responsible Conduct of Research
(Curriculum Group)
Humanities Responsible Conduct of Research
(Course Learner Group)
1 - RCR
(Stage)

Under requirements set by:

Old Dominion University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w528d53db-28f1-424d-a409-72bed1689512-34820174

Verify at www.citiprogram.org/verify/?w528d53db-28f1-424d-a409-72bed1689512-34820174

APPENDIX C

SOCIAL AND BEHAVIORAL RESEARCH TRAINING CERTIFICATE

CITI PROGRAM

Completion Date 27-Feb-2021
Expiration Date 27-Feb-2023
Record ID 41196707

This is to certify that:

Robin Dunbar

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Social & Behavioral Research - Basic/Refresher
(Curriculum Group)
Social & Behavioral Research - Basic/Refresher
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Old Dominion University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w8343a571-9578-4a04-bc14-2551a53b4f52-41196707

APPENDIX D

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

IRBNet Board Action

Inbox

Danielle Faulkner <no-reply@irbnet.org> Thu, Mar 4, 1:38 PM

TO: Robin Dunbar and Dr. Nicole Shannon Hutton

Please note that Old Dominion University Institutional Review Board has taken the following action on IRBNet:

Project Title: [1723287-2] RIVEROLOGY: Visualization, Art and Science Connect Youth to Local Rivers to Promote Stewardship
Principal Investigator: Robin Dunbar

Submission Type: New Project
Date Submitted: February 27, 2021

Action: APPROVED
Effective Date: March 4, 2021
Review Type: Expedited Review

Should you have any questions you may contact Danielle Faulkner at dcfaulkn@odu.edu.

Thank you,
The IRBNet Support Team

www.irbnet.org

APPENDIX E

CHRISTOPHER ACADEMY LETTER OF APPROVAL

February 16, 2021

Christopher Academy
3300 Cedar Lane
Portsmouth, VA 23703
757-484-6776
www.christopher-academy.org

RE: A second grade elementary school participate in a RIVEROLOGY

Dear Reviewers,

As the Head of Christopher Academy, I would like to support this RIVEROLOGY initiative for our second grade students to learn about the marine debris in the Elizabeth River this spring 2021. This project will provide our students with knowledge about maps, Elizabeth River and marine debris to connect them to their home river.

In addition, Robin Dunbar will educate the second graders and share her science journey through storytelling and show and tell on what marine debris she has found in the Elizabeth River. Students will answer inquiry question, *"What do I know or imagine about the Elizabeth River?"* The students will be encouraged to voice their opinion through drawing pictures on the importance of litter clean ups. These pictures will be given to the Resilience officers to inspire actions to reduce marine debris in our home river. Ms. Dunbar has shared that the students names will not be included on the drawings or in the research.

Christopher Academy highly recommends this project for our students and look forward to hearing the results from the research. We understand students will participate in the RIVEROLOGY activity virtually and the drawings will be used for research purposes to measure what the students have learned.

Miriam Terry

Merriam Terry
Head of School
mterry@christopher-academy.org

APPENDIX F

IMAGE PERMISSIONS

- Blue Marble: “NASA content - images, audio, video, and computer files used in the rendition of 3-dimensional models, such as texture maps and polygon data in any format - generally are not subject to copyright in the United States. You may use this material for educational or informational purposes, including photo collections, textbooks, public exhibits, computer graphical simulations and Internet Web pages. This general permission extends to personal Web pages. News outlets, schools, and text-book authors may use NASA content without needing explicit permission, subject to compliance with these guidelines.” https://www.nasa.gov/multimedia/guidelines/index.html. Accessed 30 April 2021.

- Drie, C.N. (1873) Norfolk & Portsmouth, Virginia. [N.P] [Map] Retrieved from the Library of Congress, https://www.loc.gov/item/75696645/. The Library of Congress is providing access to these materials for educational and research purposes and is not aware of any U.S. copyright protection (see Title 17 of the Unites States Code) or any other restrictions in the Map Collection materials. Library of Congress, Geography and Map Division.

VITA

Robin R. Dunbar
Institute for the Humanities, 3041 Batten Arts and Letters, Norfolk, Virginia 23529
Rdunb002@odu.edu

EDUCATION

- August 2021, Old Dominion University, Norfolk, Virginia, M.A Humanities – Cultural and Human Geography
- August 1993, Old Dominion University, Norfolk, Virginia, B.S. Interdisciplinary Studies Healthcare Human Resources

PROFESSIONAL EXPERIENCE

Ms. Dunbar is an award-winning environmental educator and storyteller, a certified National Geographic Educator, and recipient of the 2019 Presidential Award of Excellence in Science, Mathematics, Engineering and Mentoring from the National Science Foundation and the White House. She has a twenty-year career as the Deputy Director of Education with the nonprofit Elizabeth River Project with education platforms including the Dominion Energy Learning Barge, the Barge on Wheels, Paradise Creek Nature Park and Youth Resilience River Star Schools, Strategy and Expo. As a storyteller, she portrays the river's namesake, Princess Elizabeth, delivering a message of hope for restoring our river and utilizes her original stories, art, and costumes. Learn more at www.riverology.org.

RECENT PRESS

- Presidential Award 2019 *President Trump Announces Presidential Excellence Awards STEM* https://www.whitehouse.gov/briefings-statements/president-donald-j-trump-announces-presidential-excellence-awards-science-mathematics-engineering/
- Learning Barge featured in *The New York Times. Teaching Resilience in the Face of Climate Change*. https://www.nytimes.com/2019/12/02/well/family/climate-change-resilience-education.html

PUBLICATIONS

Dunbar, Robin, *Elizabeth River Marine Debris & Litter*, A Report to Elizabeth River Project's Watershed Action Team, 2021.

Dunbar, Robin, *Green Teacher*: The Learning Barge, A Model Floating Classroom of the Future, June 2011.

Dunbar, Robin, *The Not So Merry Mummichog*, A 4th Grade Curriculum to Increase Geographic Literacy, Foster Elizabeth River and Chesapeake Bay Stewardship and Empower Youth Leaders to Create a Resilient Norfolk, 2017.