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Children as "Solutionaries": Environmental Education as an Opportunity to Take Action

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Abstract

"Do You Want Paper or Plastic ?" *An Inquiry into Single -Use Grocery Bags* is an inquiry -based, solutions -focused environmental education unit developed for the U.S. Fund for UNICEF. Field -tested in two U.S. southeastern regions, the unit enga ges students as informed change makers who investigate the production, consumption, and disposal of single -use, disposable grocery bags. Based upon their inquiries, students become empowered as "solutionaries," or individuals who plan and implement action steps that lead to a sustainable futur e. Results from the curriculum pilot offer support for the importance of interdisciplinary environmental education in the elementary setting.

Keywords: curriculum, inquiry, environmental sustainability, plastic pollution, global citizenship, STEM

C URRICULUM OVERVIEW

Using large format photography , "Plastic Bags" by artist Chris Jordan (2007) (see Figure 1) depicts our mass consumption of single -use bags - 60,000 every five seconds in the U.S. alone . Statistics like these pertain to the study of everyday "stuff," including how a product is made, who invented it, the raw materials used, why and how it changes over time, and whether there is a more sustainable process to meet our human wants and needs.

Figure 1: Chris Jordan's (2007) "Plastic Bags [1]"

[1] This is for online journal use, one issue only. For any subsequent uses, permission must be obtained. Credit: Photo by Chris Jordan, www.chrisjordan.com .

A Framework for K -12 Science Education (National Research Council , 2012) reinforces the interrelated nature of science, technology, engineering, and mathematics (STEM), and inspires learners to create solutions to 21st century global challenges. Engaging in scientific inquiry about the materials economy fosters learning in all three d imensions of the NRC framework : (a) **practices** (scientist behaviors); (b) **crosscutting concepts** (those that are transdisciplinary and apply to all domains of science); and (c) **disciplinary core ideas** (key ideas that focus learning and investigation in the physical, life, and earth space sciences, as well as engineering, technology, and applications of science) . Specifically, students analyze cause and effect relationships in interdependent local and global systems, gather and analyze data, use technology in authentic ways, and explore the design and devel opment of solutions to problems . As students weigh the intended (and often unintended) effects of innovations like single -use, disposable grocery bags, they conclude there is no "best" solution, but rather many solutions to sol ve complex, global issues.

This article details the design and field -testing of an inquiry -based, solutions - focused environmental curriculum unit entitled " *Do You Want Paper or Plastic* ? *An Inquiry into Single -Use, Disposable Grocery Bags.* " Developed on behalf of TeachUNICEF , the Education Division of the U.S. Fund for UNICEF, this unit addresses UN Millennium Development Goal (MDG) #7 *Ensure Environmental Sustainability* (United Nations, n.d.). Importantly, " *Do You Want Paper or Plastic* ?" affords " opportunities for young learners to engage in exercises of ecological citizenship," says Dr. Jay Shuttleworth, a scholar of environmental sustainability at Teachers College, Columbia University. He continues:

> *This carefully considered curriculum links being informed about sustainable living with matters of civic responsibility. Through potentially existential inquiries about where consumer goods "come from" and discarded items "go," this curriculum also creates the potential for students to recognize the interconnectedness of the natural world. Most importantly, the lessons may lead participants -- with minimal prodding from the teacher -- to conclude that the answer to "paper or plastic?" may be derive d from a di fferent source altogether (like, "I brought my own bags."). Thus, the instructional objective of students as "solutionaries" offers possibilities to challenge assumptions about consumer habits, and as a result, forge new paths of understanding and action -taking.* (J. Shuttleworth, personal communication, June 24, 2015).

Informal science educator and doctoral candidate at the University of Maryland College Park, Emily Hestness, agrees. " *Do You Want Paper or Plastic* ?" helps to meet the " growing need for curricular materials that help educators to foster the competencies, knowledge, dispositions, and actions necessary for en vironmentally literate citizens (E. Hestness, personal communication, June 24, 2015). It also easily connects to existing curriculum standards (e.g., Common Core State Standards, Next Generation Science Standards), says Dr. Scott Morrison, Assistant Professor at Elon University with a specialization in environmental and ecological studies (S. Morrison, personal communication, June 29, 20 15).

Intentionally flexible in design, *"Do You Want Paper or Plastic* ?" is adaptable to diverse early and elementary grades and contexts, as teachers consider students' prior knowledge, experiences, and interests in exploring sustainability issues and possible solutions to resolve them. The focus on student inquiry is key, as it " allows teachers to adjust lessons based on student knowledge, ability, and interest " (S. Morrison, personal communication, June 29, 2015). Further, the content is relevant to t he lives of students. Morrison continues: "[Students] all consume products and participate in what Annie Leonard calls 'the materials economy.' What they see, use, and throw away everyday becomes part of the curriculum."

Figure 2. Photograph of beach plastic on a Taiwanese shore (Terry, 2014).

Finally, although " *Do You Want Paper or Plastic* ?" focuses on one specific issue, the inquiry design allows the content to be easily substituted. Hestness explains, " [this resource's] approach may be applied to the investigation and analysis of myriad environmental issues of personal rel evance and interest to learners" (E. Hestness, personal communication, June 24, 2015). Morrison concurs, adding " the inquiry -based structure is a model for other units on sustainability, so the use of the guide extends beyond the paper and plastic bag issue" (S. Morrison, personal communication, June 29, 2015).

RATIONALE

As children develop as learners and thinkers from birth through high school, it is their teachers (including parents) who help shape their understanding of the world directly around them and, by extension, the world as a whole. This understanding is multifaceted and includes understandings related to the natural world and the interaction between humankind and the environment (Duhn, 2012; Pearson & Degotardi, 2009). It is important, as Christenson (2004) notes, for teachers to help young children develop critical thinking about their world by teaching them that human in teractions and decisions that impact the environment are made for both diverse and complex reasons. By examining and understanding these cause and effect relationships, children can develop the ability to make more informed and deeply considered decisions , not only about the environment but , how they view and interact with the choices that others make. Christenson further states that for young children "environmental education (EE) must also help develop the social knowledge and critical thinking skills th at are necessary for examining diverse viewpoints on environmental issues" (p. 3).

While many early childhood and elementary teachers affirm the need to teach EE , some are reluctant to do so for a variety of reasons including concerns with covering potent ially controversial content, frightening students with exploration of destructive human or natural events, or potentially upsetting parents (Christenson, 2004; Duhn, 2012). " Too many teachers leave students feeling helpless in the face of environmental destruction," explains Morrison (S. Morrison, personal communication, June 29, 2015). Research supports this notion. As Özsoy and Ahi (2014) studied the drawings of elementary c hildren depicting the current and future state of the environment, for example, they found that children's perceptions ranged from hopeful to bleak. What may be inferred from these findings and from others (e.g., Davis, 2009) is that young children have a beginning context for understanding and representing the environment yet there is also a need to help children engage in exploration and inquiry so that they may more deeply comprehend environmental issues such as sustainability, recycling, and social acti on. Instead of overwhelming students, " *Do You Want Paper or Plastic?* " is designed to empower students to consider the positive differences they can make.

The need to address EE using effective and innovative approaches is indeed reflected throughout the world (Conde & Sanchez, 2009; Dimopoulos, Paraskevopoulos, & Pantis, 2009; Sagy & Tal, 2015) as schools, teachers, and educational systems turn their focus to developing and implementing meaningful and authentic integrated units of study to address topics related to exploring, understanding, and caring for our global resources and environment. Dimopoulos, Paraskevopoulos, and Pantis (2009) field-tested a module for young children that focused on endangered species in protected areas with positive results affirming the use of this model for future EE units of study. Sagy and Tal (2015) presented a landscape view of EE in Israel's schools looking at both historical and current practices and encouraging increased commitment from systems and teachers to integrate environmental education in the curriculum.

Further, Conde and Sanchez (2010) investigated the influence, effectiveness and efficiency of environmental education using an eco-audit approach in 13 primary and pre-primary Spanish schools. Their findings gathered via participatory action research methodology indicated progress in successful integration of EE but also the need for further research into the "treatment of the content, the preparation of materials, [and] the motivation and habits and attitudes of the pupils" (p. 491). Additionally, conducting research on the potential of EE curricula to positively impact the hearts and minds of young learners with regard to the environment is specifically needed. Research studies of this kind are gradually increasing, but as Hardy (2011) asserts, there is a continued need for empirical and robust testing of EE curricula's effectiveness in "cultivating responsible environmental behavior and other components of environmental literacy (know ledge, affect, and skills)" (p.1).

In another study, Forbes and Zint (2010) found that certain elements must be in place for elementary teachers to strengthen and develop their beliefs about and practices related to the power of inquiry to support children's learning about the environment. One of these factors was access to appropriate and meaningful EE curriculum materials. While there exist many curricula that address topics inherent in EE, such as sustainability and social action, what makes "*Do You Want Paper or Plastic?*" unique and particularly helpful for teachers of early and elementary learners is the natural integration of many essential ideas and practices that incorporate multiple subject areas. While other curricula may include some important knowledge, skills, and dispositions related to current educational practice, including EE, this unit seeks to inclusively weave together essential 21st century skills (Partnership for 21st Century Skills, 2009) including: inquiry (e.g., research processes, critical thinking, collaboration, and problem solving); multimodal, environmental, and global literacy; environmental awareness of the interdependence of all living things; and the authentic and developmentally appropriate use of technology to represent knowledge and understanding.

Resources were indeed purposefully selected in the development of "*Do You Want Paper or Plastic?*" As Christenson (2004) found in her action research with fellow elementary teachers, using quality children's literature was an effective strategy in teaching multiple perspectives and critical thinking about the environment including issues such as recycling. *"Do You Want Paper or Plastic*?" includes high quality children's literature throughout to scaffold students' ability to take multiple perspectives and their understanding of concepts related to the materials economy and the positive and negative effects of innovations on humans, animals, and the environment, as highlighted in Table 1 (see next page).

Table 1
Sample Descriptions and Applications of Children's Literature in "Do You Want Paper or Plastic"?

Book Title	**Brief Description and Application**
Browne, A. (1998). *Voices in the park.* New York: DK Publishing.	The same story is told from four different perspectives illustrating to the reader that there is more than just one way to interpret an event, situation, or setting. Students can discuss and write about examples from their own lives in which they saw multi ple perspectives at play. Younger children can explore and share the differences between fact and opinion and accept that they may differ from their peers in how they feel or think about a particular situation or idea related to the environment.
Claybo urne, A. (2007). *The story of inventions* . Tulsa, OK: EDC Publishing.	The history and impact of a variety of inve ntions (e.g. spectacles, jeans, computers) is described with a unifying theme that innovation has an effect on our society and the way we live. Students can research other inventions as part of their inquiry and can also brainstorm and discuss inventions that have impacted their lives and the world around them. Younger children can collaboratively create a class picture book choosing and drawing an invention and then listing one way it helps them and one way it may negatively affect their life or their environment.
Deedy, C.A. , & Seeley, L. L. (1994). *Agatha's feather bed: Not just another wild goose story* . Atlanta: Peachtree Publishers.	In this children's book the theme of " *Everything comes from something, / Nothing comes from nothing* " is reinforced in an engaging and humorous story. Teachers can use this book as a springboard for a discussion on renewable or non -renewable resources. For yo unger children, photos of renewable and non -renewable resources can be sorted as part of a learning station or guided small group activity.

In addition to understanding and engaging in inquiry about the environment, children should also examine and discover ways to take action for making their world a healthier and more sustainable place (Locke, 2009). Through investigating case studies of pra ctices and attitudes toward consumption among elementary Dutch children, Kopnina (2013) found that some students, particularly those of lower socioeconomic status, "exhibited less awareness of environmental impact of consumption and less belief in their ow n agency in bringing about positive change" (p. 131) while others were able to "perceive the link between (over) consumption and [the] environment" (p. 133). The variability of these results may indicate a need for focused early childhood and elementary cu rriculum that encourages not only awareness but also support for students to make changes in their individual behavior as well as take social action to improve the environment. Strong environmental education curricula that are cross - disciplinary as well as socially conscious can be supported by children's literature as stated above (Christenson, 2004), as well as by the innovative uses of digital technologies (Willis, Weiser, & Kirkwood, 2014). In each lesson, *"Do You Want Paper or Plastic* ?" offers sample t echnology applications for use by teachers and students, as appropriate based on students' ages and context. Sample digital resources and their possible applications are detailed in Table 2.

Table 2
Sample Descriptions and Applications of Digital Resources in "Do You Want Paper or Plastic"?

Digital Resource	**Brief Description and Application**
Animoto: Video creation (https://animoto.com/)	Children can upload images and add captions, audio narration, and music to create an online video that shows what they have learned as a result of their inquiry and/or to support ways in which they "take action".
Delicious: Social bookmarking (https://delicious.com /)	Teachers and students can collaboratively store and publically access web sites that guide and support their inquiry in one online location. Links can also be categorized and annotated based on topics related to their study of sustainability and the enviro nment.
Glogster: Online posters (http://edu.glogster.com /)	This tool supports students to create digital, interactive posters on a website that specifically targets K -12 classrooms. Children can embed and link to text, images, audio and video files to represent content, ideas, and perspectives related to their research.
Padlet: Wonder Wall online (https://padlet.com /)	Collections of student questions or "wonderings" as they begin and throughout the unit can be posted and collected either publically or behind password protection on this digital board. The web link to students' questions can also be shared with parents.

Lastly , Davis (2009) asserts the need for more research related to environmental education and early childhood including investigat ing the effectiveness of multidisciplinary and social action oriented curricula, "exemplars of practice" (p. 235) such as the field -tested unit of curriculum described in this article.

THE CURRICULUM

" *Do You Want Paper or Plastic* ?" includes six lesson plans with recommended extension activities. Scaffolded using Kath Mu rdoch's (1998) inquiry model , students learn about the origin of common goods, the effects of consumption on living things and the environment, and why governing bodies worldwide have im posed restrictions on single -use plastic bags. The unit follows the philosophy of solutionary education, defined by the Institute for Humane Education (n.d.) as:

> *Someone who identifies inhumane, unsustainable, and exploitative systems and then develops practical, effective, and visionary solutions, both large and small, to replace them with those that are restorative, healthy, and just. Solutionaries bring their knowledge and skills to bear on pressing and entrenched challenges in an effort to create positive changes for all people, animals and the earth.* (paras. 1 -2)

Making informed decisions regarding consumption habits is deemed a civic responsibility and aims to empow er children as individuals who plan and implement action steps that lead to a sustainable future. This unit outlines how educators may implement inquiry -based teaching and learning about the specific issue of single -use,

disposable grocery bags; however, any material good and its related environmental and human health issues can be researched, analyzed, and acted upon by students .

First, we developed a curriculum framework stru ctured around the Murdoch inquiry model, outlining broa d, open - ended questions and enduring understandings, or transferable "big ideas." Afterwards, we created topic -specific questions related to the specific issue of single-use grocery bags (Table 3). While the sequence of these questions is intentional and g uide students' investigations and decision - making, they also afford flexibility. The unit neither intends to answer questions for students nor to instruct them how to develop solutions to the issues presented . Students are encouraged to delve deeply into the problems, to draw their own conclusions, and to make decisions regarding how they may be "solutionaries".

Table 3
"Do You Want Paper or Plastic?" Curriculum Framework

Lesson	**Enduring Understanding**	**Overarching Questions**	**Topical Questions**
Lesson 1: "Tuning In" to Consumption	The goods we purchase are made from limited natural resources; therefore, we must make informed, thoughtful choices as consumers.	Where do the goods come from? How are goods produced and distributed?	What are paper and plastic bags made from? How are they produced? How are bags distributed to local grocery stores?
Lesson 2: "Finding Out" about Human Innovation	Scientific discoveries and technological innovations affect the way society functions. These changes may result in predictable /unpredictable, positive / negative effects on living things and the environment.	How do advancements in science and technology affect society?	What led to the production of paper and plastic bags? How h ave they evolved over time and why? What are the perceived benefits and drawbacks of paper and plastic bags to society?
Lesson 3: "Sorting Out" Diverse Perspectives	People have diverse perspectives that may explain the behaviors of individuals and groups. Sometimes these different points of view lead to conflict.	What does it mean to have a perspective or point of view? How does one's perspective affect or influence one's behaviors?	What perspectives do stakeholder groups have regarding the product ion, consumption, and disposal of paper and plastic bags?
Lesson 4: " Going Further " : Local to Global Bag Politics	Governing bodies affect the choices or decisions we make as consumers through the implementation of laws and policies.	What i s the role of the government in regulating the production, distribution, consumption, and disposal of products?	What local, national, and international laws and policies have been passed regarding paper and plastic bags?
Lesson 5: Making Conclusions, Making Informed Choices	Being an informed citizen is a civic responsibility.	What are the effects of consumerism on humans, other living creatures, and the environment?	What happens when paper and plastic are thrown away? Where is "away"? What are the eff ects of disposal?
Lesson 6: " Solutionaries" Taking Action	An individual's choices and actions can have a positive impact on others and the environment. Anyone can be a "solutionary"!	How can individuals, groups, and nations work together to solve problems?	In what ways can I make positive choices regarding consumption of goods to lessen my impact on the local environment and the entire planet?

The Inquiry Model

Each lesson plan includes two parts. Part I builds interdisciplinary background knowledge. Part II outlines the teacher’s facilitation of the inquiry model that we made into a student -friendly poster to be displayed in the classroo m (Figure 3). Subsequent sections of this paper describe each stage and its relationship to the content under study . Reflective of the unit’s flexible design, the teacher may determine students have ad equate prior knowledge and skills addressed in Part I and proceed to Part II. Within each lesson, a variety of resources are provided, including sample children’s literature and technology tools for teaching and learning, as explained previously.

Field - Testing the Inquiry

We field -tested the unit in six third -grade classrooms located in two regions: coastal Georgia and western North Carolina. The classroom teachers taught the lessons and were asked to provide written feedback regarding their effectivenes s, as well as to suggest improvements. Each student maintained an inquiry journal and completed authentic projects, offering insights about their mastery of the unit goals and objectives.

Figure 3 . Kath Murdoch inquiry cycle.

Pre -Assessment: Causes and Effects of Environmental Issues

Prior to beginning the unit, each student completed a pre -assessment table of knowledge and perceptions in his or her inquiry journal. During the pilot, it was evident that most third graders understood cause and effect relationships *and* could identify specific examples that related to human -environment interactions. This allowed teachers to begin Lesson 1 without introducing or reviewing this overarching concept as it is woven throughout the unit. Table 4 highlights a c ompilation of written responses from both regions. (Note: To maintain the integrity of the students' original voices, their words are presented throughout the manuscript in the original spelling and grammar).

Table 4 .
Student Pre -Assessment of Human -Environment Cause and Effect Relationships

Issue or Problem	What Caused It?	What are the Effects?
Littering	Throwing trash in environment	Harm the environment
Oil spills	Explosion	Animals die
Paper bags	Grocery shopping	Killing trees
Animals coming into cities	Humans tearing down habitats Not too many predators	Animals coming closer into cities and towns
Deer are overpopulating	People	Deer create big troubles
Cutting down trees	Careless people	Less oxygen
Wasting water	Driving car	Less water to drink
Gasses/pollution	Matches	Harm to animals
Fire		Burn
No trees	Too much paper made	No habitat for animals
Damage	Hurricane or tornado	The world world
Bad water	Lead	Getting sick
Pollution	Oil spill	Oil in the water

Lesson 1: "Tuning In" to Consumption

> *Everything comes from something,*
> *Nothing comes from nothing.*
> *Just like paper comes from trees,*
> *And glass comes from sand.*
> — Carmen Agra Deedy
> (Excerpt from *Agatha's Featherbed: N ot Just Another Wild Goose Story)*

Prompted by common household items such as canned goods an d shampoo bottles, students explore the origin of everyday products. *Where have you seen these items? How are they used? What do you know about how they are made?* They discover that all goods have a *story* or a *life cycle* —how they are manufactured or produced, shipped or distributed, and used and disposed of by consumers. At their basic, raw level, all products are made from natural resources. Following a teacher - guided discussion and a read -aloud such as *Agatha's Fea therbed* by Carmen Agra Deedy and Laura L. Seeley (1994) , students learn whether the natural resources used to make goods are renewable or non -renewable. They can then create a graphic organizer such as a T - chart using *renewable* and *non* -

renewable as headings and then list the resources in what they think is the correct column . Feedback from the pilot indicated that most students categorized resources similarly, labeling trees as *non -renewable* . Although most trees can be classified as renewable, th e students were indeed correct: some trees do take longer to regrow than humans currently use them. This resulted in our revision of the final unit, clarifying that some natural resources are both renewable *and* non -renewable.

In Part II, s tudents begin their inquiry by "tuning in . " The teacher displays a paper bag and a plastic bag. Students record what they *think they know* and what their *wonderings* are about this issue in their inquiry journals. The teacher can also designate wall space within the classroom, often referred to as a "Wonder Wall ," on which students post their questions or "wonderings" on sticky notes. These notes , with their questions, serve to support and document their investigations. Sample student "wonderings" from the pilot included:

- *Why do people litter and hurt our environment?*
- *What will happen if we keep littering?*
- *How many trees die to make paper, and how many animals die because of plastic in the ocean and on land?*
- *What is plastic made of?*
- *Is paper better than plastic?*
- *How you could destroy plastic better , so it does not hurt the environment.*
- *I wonder what if we lose trees and the oils, what will happen to earth?*
- *I wh ant to know how we can make sure people do not wa ist pap er or plastic because if you wa ist paper and plastic for something really waist ful and then throw it away we wouldn't have a lot of paper or plastic, and then we won't have a lot of trees for paper.*
- *I want to find out how many things that are in the trash, that are supposed to be rycicle d.*

Students' questions focused their research throughout the inquiry and were revisited in each lesson.

Lesson 2: "Finding Out" about Human Innovation

The second lesson builds students' understanding of the production of goods with a focus on *why* new goods are made to replace older products or ideas. By reading books like *The Story of Inventions* **(** Claybourne & Larkum , 2007), students discover the intentional and unintentional co nsequences of human innovation . They record reflections to question s such as: *Is a new discovery or technology always better than that which it replaces? Why or why not* ? Student responses suggested that innovations like iPads were overall positive, but that not all technologies improve human life. For example, one student wrote, " Som people like books better than nooks." During Part II, s tudents participated in small research groups, taking notes from a variety of print -based and dig ital sources that were saved on a c lass social bookmarking account (Figure 4).

Whereas most students focused their research on commonly used technology tools, others researched the specific innovation of paper and plastic bags. Handwritten notes based on print -based and digital research included:

- *First plactic sandwitch bag was made in 1957. Be tween 25 and 30 percent of packing for bread is plactic. Only 1 to 2% of plastic are getting recycled in the USA. Paper is better.*
- *Approx. 380 billon bags are used in the united states every year. That's more than 1,200 bags per year. In 1852 paper bags we re made 1852 -2012 In 1957 plastic bags were made, 1957 -2012*
- *1957- First plastic sandwich is made. 1966 - Between 25 and 30 percent of packing for bread is plastic. 1969- New York City begins collecting garbage in plastic bags. 1974 - Retail giants sears and J.C. Penny switch to plastic shopping bags. !977 - Super markets begin to say: paper or plastic? 1994 - Denmark creats firs plastic bag tax. 1997 - Over 80% of all bags used are plastic. 2002 - Ireland interduses the worlds first consumer paid plastic bag tax.*

- *There are diffrant plastic bags and are used for many purposes. In 1996 over 80% of all bags used are plastic. In 1957 the first sandwich bag was made. Approx. 380 billion plastic bags are used in the United States every year. That's more than 1,200 bags per US resident, per year.*

Early in these investigations, students determined the complexity of human innovations and how they can result in both beneficial and harmful impacts on humans, animals, and the environment.

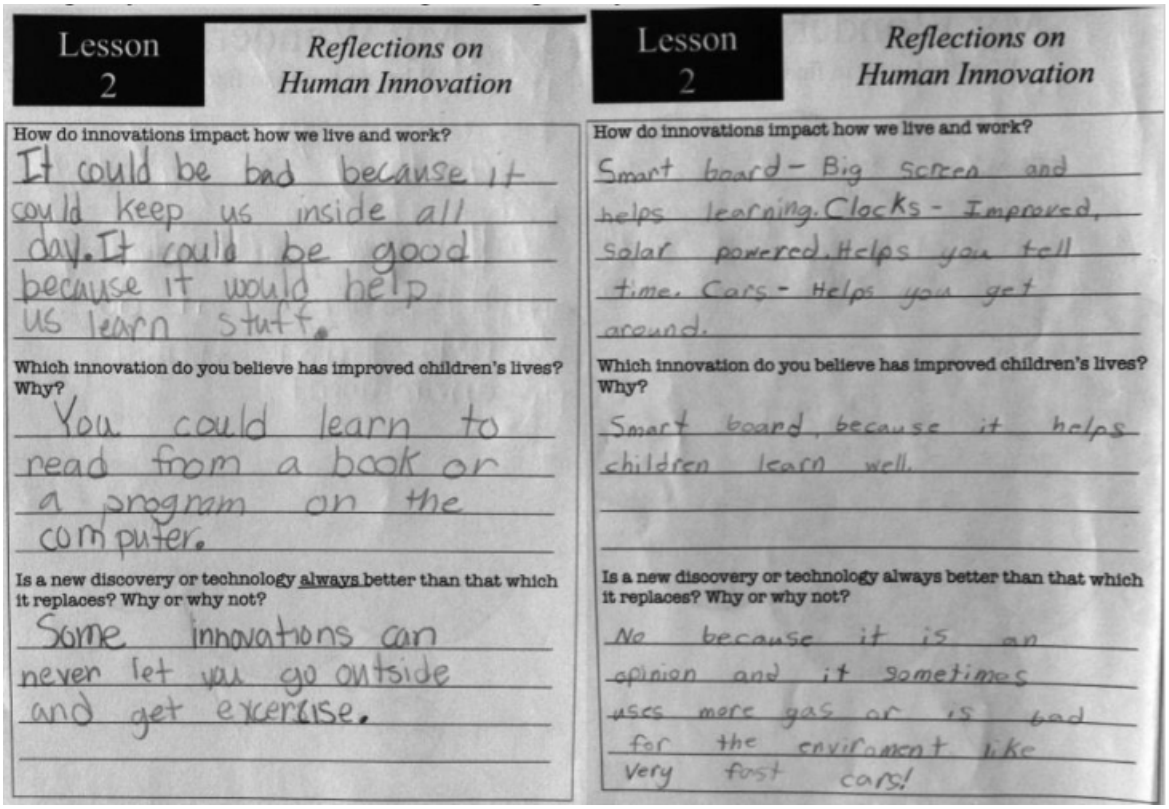

Figure 4 . Georgia (left) and North Carolina (right) third grade student reflections on human innovation.

Lesson 3: "Sorting Out" Diverse Perspectives

In this third lesson, students' skills in perspective -taking are enhanced through reading and discussing a work of fiction, such as *Voices in the Park* (Browne, 1998), relating point of view and author's voice to stakeholder perspectives. By being introduced to a variety of persp ectives, students begin to *sort out* their research findings and to validate sources of information as they continue their investigations. They also reflect on their *feelings* during the inquiry, determining whether and how they have changed. Contrary to the lesson's focus on flexible thinking, the majority of students shared that their feelings remained constant, with most expressing persistently negative perceptions of plastic. "I still think paper is better because it decomposes quicker and paper is made o ut of trees and uses a renewable resource," one recorded in her journal. Another wrote:

> *I feel like paper & plastic are two very very different things. [Have my feelings changed? Why or why not?] No, because I still lik paper much much more. I like paper more because it is better for the envirerment and decomposses faster.*

Another student supported this belief: "My feelings haven't changed. I still think plastic is worse." Some admitted to feeling affirmed by their unchanged perspectives. For example, one wrote: "I feel great about what I've learned. My feelings have not changed. All of our research is leading to paper." Unaltered perception s aside, another

explained that research has been helpful because “I have bin learning many more ways paper is better than plastic.”

A few students expressed being up set by what they were learning (even if feelings remained the same) . For example, one student wrote, “I feel sad because some animals died. My feelings haven’t changed.” Another shared:

> *I am mad a bout what I have been learning. People are littering way too much. A lot of trash is going into the ocean and killing animals. My feelings have not changed because I still think paper is better.*

In sum, while a few students in each class did express changing their perspectives as a result of the inquiry (e.g., “My feelings have changed a little bit because I didn’t recycle and used to use plastic bags”), the majority expressed unchanged beliefs. This finding suggests, perhaps, that some students may be less open to new informat ion that changes the ir existing core belief structure about the environment and issues of sustainability.

Lesson 4: Going Further - Local to Global Bag Politics

Students *go further* in their inquiry by learning how local, national, and international groups have responded to this issue of single -use, disposable grocery bags. The child - friendly version of the documentary film *Bag It!* (Hill & Beraza, 2010) and websites such as Chico Bag (https://www.chicobag.com/track - movement) (2014) allow one to “Track the Movement” around the world. Students conclude how complex, controversial, and ever evolving are environmental concerns, economic systems, and politics. Through collaborative research, students discover that policies set in place by governing bodies affect consumers’ choices. During the pilot, many students expressed disdain for taxes and regulations, such as fees imposed on single -use grocery bags. Sample written comments included:

- *It is not fair to other people to get charged for what they buy becq use they will run out of money.*
- *We should be able to use what we want to do! Government you stink.*
- *It’s not fair to us. Because maybe we can't pay that much.*
- *We should be aloul d to use pla stic k bags.*
- *I don t think it is fair because some people need bags and don t want to pay 10 cent.*

Other students appeared to support governmental regulations when human activity causes harm. For example, one wrote that bags “can get in the ocean or kill an imals.” Another agreed: “[the government] may place a ban because it is polluting the envirment .” Finally, one student specifically referenced the role of government in protecting human safety: “People throw their single -use plastic bag on the road and could get co ught in other people on the road and could reck .”

Lesson 5: Making Conclusions, Making Informed Choices

Drawing upon their research -based findings and reflections , students begin to *make conclusions* regarding the issue under investigation . They learn about human rights by watching *Cartoons for Children's Rights* (UNICEF , 2004) and discover their related responsibilities to one another and to the environment . Students reflect upon how their ideas and feelings have changed throughout the inquiry , ultimately deciding upon what is most essential to communicate with others. Co nclusions made by students during the pilot varied, some citing specific statistics they wanted to share, others explaining the negative effects of both paper and plastic bag production and disposal. Sample written statements included:

- *Both Plastic and PaP er are bad because Plastic is bad for the enviromen and PaP er cuts trees and we would not have any oxshu gen and we will die.*

- *Americans use about 100 billion plastic bags per year. Paper bags are better for the enviro ment . Paper goes through a better pro sses of recycling.*
- *I think we should put a ban on plastic. Using a high quality bad helps stop you from using dispose ble begs each year I think we should have all of* those rights from the story.

Several students commented specifically on the inquiry process, calling it "fun," whereas others elaborated: " Research is in portant because you look things up and you get to know more about paper and plastic. And keeping our enviro ment safe and clean! " We were pleased to learn that many students expressed awar eness that being informed is a n essential part of one's civic duties .

Lesson 6: " Solutionaries" Taking Action

In this culminating lesson, students determine how they can become change agents . Inspired by "solutionaries" worldwide, stu dents review a list of possibilities in their inquiry journals , such as "design a poster by hand or using technology (e.g., Glogster)" or "write a script and create a video (e.g., Animoto) to promote awareness." Students decide how they will take action. The North Car olina third graders chose among the options, some crafting a sign - up sheet to "join the environment club" and collecting peers' signatures. Unfortunately, due to time constraints at the end of the school year and standardized testing in the 3 rd grade, they were unable to implement their plan. In contrast, t hrough a coordinated effort of the teachers, students, and parents in Georgia , the school participated in a community "Let It Shine" art exhibit. The third graders designed artwork and selected thei r favorite (Figure 3), which was screen -printed on reusable cloth bags and sold to raise money for UNICEF . In collaboration with a local environmental artist, they also created a quilt made of plastic bags and large -scale sculptures using recycled material s (Figure 5). The students put STEM into action through their research, design, and implementation of their chosen solutions, which was personally meaningful and had an impact in their communities.

Figure 5. Original student artwork to bring awareness to the issue of single -use, disposable grocery bags.

Figure 6. Student- created plastic quilt and fish sculpture using recycled materials displayed at the community art exhibit.

CONCLUSION

To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science.
— Albert Einstein

" *Do You Want Paper or Plastic?* " challenges learners to consider the complex relationships between environment, society, technology, and science – including ethical questions they may face as consumers and citizens – and, ultimately, to translate these deliberations to informed and resp onsible action" (E. Hestness, personal communication, June 24, 2015). As a common household good, disposable bags were relatable to students in both regions. Although student perceptions of paper and plastic remained largely unchanged as a result of the in quiry, they expressed genuine concern, particularly f or animals and the environment. Students wanted to take action at the local level to bring awareness to the community using their design skills . As the authors of *A Framework for K - 12 Science Education* emphasize, science education " should help students see how science and engineering are instrumental in addressing major challenges that confront society today" (NRC, 2012, p. 9). The curriculum pilot provided evidence of this critical need.

Teachers part icipating in the pilot also expressed how their involvement improved their own teaching practices, knowledge of environmental issues , and personal behaviors . One commented that the unit pilot prompted her to be more "purposeful" as she approaches teaching issues of environmental sustainability across the curriculum. Another shared:

> *I was amazed at how involved and interested students became in the environmental issues. This made my perception a lot more positive in the fact that these students care so muc h about this issue. Also, this pilot made me begin practicing what I preach. I since have bought these two canvas baskets that fold flat that I keep in my car to carry my groceries to avoid ever using plastic bags.*

Another reflected upon the positive impa ct of students' passion for the subject matter. "My students would not let me throw ANYTHING away. I have begun using the cloth bags that were stuffed in my trunk more often," one

teacher shared . A different teacher agreed that the unit " definitely opened my eyes and opened a new door to a number of ways that I can take my part in keeping the environment cleaner and protect my BEAUTIFUL environment! "

As with all curriculum pilots, our work was not without its challenges, with time constraints being most restrictive . " In reality we have about 30 minutes a day to teach the science standards," one teacher commented. As a result, many classroom teachers were unable to complete the unit and to fully support students' action -taking due to end -of- grade testing and the amount of dedicated time needed to thoughtfully implement the lessons and inquiry cycle. One veteran teacher expressed frustration that " there is neither time nor space in the curriculum for [teachers] to implement [meaningful] curriculums to the d egree that t hey should be" and that he is " very disapp ointed that we did not complete/ implement the curriculum to the degree we should have - this was an injustice to the curriculum (which is extremely well thought out and written)." Another teacher at the same school agreed :

> *The one thing I would say that did not work too well was the time frame that I was given to teach the lesson. There is A LOT of information in this unit, and it is somewhat unreasonable to teach all of the conte nt with the small amount of instructional time given for science. All great and important information, just not sure that it is AS important as the others considering the amount of time it demands (like language arts, reading, or math) due to testing of th ese other subjects.*

Although "excited" to teach the unit, another commented that the "reality of time constraints prevented me from getting through the entire thing as efficiently and thoroughly as I would have liked."

The diverse use of technology tools was also deemed both beneficial and frustrating. One teacher shared how technology can engage students in the lear ning process in unexpected ways:

> *I had not ever used technology prior to this experience as much as I did in this unit. I would typically use technology in the presentation of the material I was teaching; but through this unit, I used it in every way possible. Not only did I teach with the technology, but also I allowed the students to use it as well through an e xtended project. They had not even seen the computer that many times throughout a week prior to the unit. They were extremely excited about that, I might add. ;) I also want to mention that one of my students followed the unit up (without being asked) with a PowerPoint presentation containing information about what she learned. She claimed that she would "Show it to friends so that they will no more about how to save our planet!"*

Several teachers also commented that the tools allowed them to be more effici ent and taught the students new skills. The social bookmarking site *delicious.com* was considered valuable as it "led students right to what you need them to see, but then it also let them begin learning researching skills by searching for answers to questions asked of them," one teacher shared. T echnology malfunctions could be frustrating , however . "Several of the links were broken," one teacher wrote. Although time constraints prohibited one from fully incorporating technology in the unit's lessons, one teacher plans to "spend some time learning moviemaking /editing techniques so that we could have realized s ome of the projects undertaken."

In closing, environmental education researcher Scott Morrison underscores that " Students must be taught not only about what is wrong in the world; they must also be equipped with the skills necessary to advocate for peace, justice, and sustainability. [" *Do You Want Paper or Plastic?* "] is a step in that direction" (S. Morrison, personal communication, June 29, 2015). When immersed in the study of "stuff," students engage in deep , critical thinking about their roles as consume rs and how they can be change agents. As the pilot results suggest , deep, integrated learning *does* require dedicated time and support. These findings reflect prior research on teaching EE as teachers express concerns regarding the time required to plan and teach environmental topics (Christenson, 2004). Indeed, there is documented need to approach EE from a multidisciplinary and cultural perspective with a focus on sustainability (Davis, 2009; Duhn, 2012). Environmental education should not be reserved for one content area (such as science) or one 30 - minute time frame after other more seemingly critical subjects are taught (e.g., ELA or

mathematics). With appropriate scaffolding , we believe that children *can* be empowered to see themselves as "solutionaries" who change their personal choices to contr ibute positively to their world, who develop larger solutions that addres s broad issues such as environmental sustainability. We hope that " *Do You Want Paper or plastic ?*" is one such resource to support teachers in these efforts.

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