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Introducing Science Education in Early Childhood

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A Capstone Project for the Bachelor of Arts in Human Development and Family Studies

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Introduction

There is a lack of science education within preschool classrooms. Children can benefit from early science education because it teaches STEM skills, new approaches to learning, and environmental stewardship. To address the lack of science instruction in preschool education, I created a 2-session curriculum about the water cycle and storm drain pollution for Ms. Kelly's class of 4 to 5-year-olds at the Hollister Presbyterian Cooperative Preschool in Hollister, California.

Needs Statement

The increasing focus on literacy development and kindergarten readiness in preschool has created a lack of science education in early childhood education. In recent research, Head Start found that of the four academic readiness domains for preschoolers (i.e., language, literacy, math, and science), science is the lowest-performing area amongst students in their program (Bustamante, White, & Greenfield, 2018). Research is showing that declining performance in science is partly due to the lack of science education in classrooms. Lack of science is not only affecting school performance down the road but it also limits children in receiving the benefits of early science education. Science education provides numerous developmental benefits for young children: development of STEM foundations to improve later learning, development of new approaches to learning, and the development of environmental stewardship.

STEM (science, technology, engineering, and mathematics) learning is typically introduced in elementary school and continued in high school. However, research indicates that

STEM practices in early childhood can encourage continued success at primary, secondary, and post-secondary levels (Tippett, & Milford, 2017). Given that parents feel that preschool aims to prepare their children to develop skills that are essential for successful learning in elementary school (Einarsdottir, 2019), STEM education utilizes the development of science skills (i.e., early critical thinking, reasoning, and inquiry skills) that are beneficial for later learning (Tippett, & Milford, 2017). STEM educators also have drawn importance in connecting curriculum to real-life contexts by aiding children to make sense of the world independently (Holmlund, Lesseig, & Slavit, 2018). Sensemaking encourages preschool children to form independent opinions, ideas, and predictions that are all skills vital for future development and educational success.

Hypothesizing, seeking answers, planning, and further exploration are all involved in scientific inquiry that could introduce new approaches to learning to the child (Bustamante, White, & Greenfield, 2017). Preschool children's approaches to learning are skills children utilize to develop an understanding of the information taught, which could play a significant role in later learning. Science helps children in developing new methods of learning as the process employs trial and error, experimentation, persistence, and close attention to detail (Bustamante, White, & Greenfield, 2018). By studying science in early childhood classrooms, the children can develop new approaches to learning soon, rather than waiting until elementary school to develop these skills. In a recent study, researchers found that the inclusion of science in early childhood encouraged school readiness in children who transitioned into primary education (Bustamante, White, & Greenfield, 2017). By utilizing

science education in preschool, children are practicing skills of learning that are preparing them for future capabilities.

Environmental stewardship signifies the idea of taking care of the natural environment through conservation and other sustainable practices through the responsible use and protection of the natural environment. To address growing environmental issues, Kabadayi and Altinsoy (2018) suggested that people need to develop an awareness of humanity's impact on the world. Considering that children in early childhood are absorbing new ideas of the world, science education can encourage children's attitudes, behaviors, and awareness of environmental protection (Kabadayi & Altinsoy, 2018). In determining the effectiveness of teaching young children ecological science education, Hsiao and Shih (2016) found that children were able to recognize the impact of human behaviors on the environment. Children in this study displayed enthusiasm in changing their behaviors upon reflecting on their own lives and daily routines (Hsiao, & Shih, 2016). Science education provides the opportunity to teach children the reasons people should respect nature and value conservation. Introducing this concept at an early age could increase children's knowledge of the world and encourage environmental sensitivity.

Science is a fundamental subject that requires attention in early childhood education (Bustamante, White, & Greenfield, 2018). Science education provides benefits for later learning with its foundational STEM influences, the development of learning approaches, and also in teaching environmental sensitivity. To promote science education in early childhood, I intend to implement a three-day lesson on explaining the basic knowledge of the water cycle and the

impacts of runoff pollution at the Hollister Presbyterian Cooperative Preschool in Hollister, California.

Theory

Piaget's cognitive developmental theory encompasses how humans can gradually obtain, construct, and use their knowledge. Piaget asserted that children think differently than adults, and proposed that children between the ages of two and seven are in the preoperational stage of cognitive development. In this stage, children utilize symbolic thinking which includes the child's ability in using symbols to represent objects mentally (Lyng, 2018). Piaget's theory also suggests that children in the preoperational stage are still building experiences about the world while working towards logic and operational thought. Since the participants range from three to five years old, this project will challenge their cognitive development as they utilize symbolism and are introduced to more advanced logical thinking within ecology.

One element of Piaget's preoperational stage is the child's ability to use symbolic representation. Language use is an example of symbolism for children as they can use words to stand in place for something else (McLeod, 2018). For instance, a child who pretends to talk into a banana similar to a telephone or riding a broom as if it were a horse is utilizing symbolic thinking. In my project, I intend to teach Ms. Kelly's class a simplified version of the water cycle. The following day, I will utilize shaving cream in a cup of clear water to symbolize rain clouds in the sky. Children will then use pipettes filled with blue watercolor to symbolize rain. When water fills the clouds up following evaporation, their shaving cream cloud will eventually be too dense, leading to rainfall. The use of other objects (i.e., shaving cream and watercolor) to

replace the ideas they learned from the water cycle allows them to utilize their symbolic thinking. I'm hoping participants will recognize and make connections of how precipitation happens in our natural world when seeing the blue-dyed raindrops fall from their shaving cream clouds.

Within the preoperational stage of cognitive development, it suggests that children act based on intuition rather than logical reasoning. Children don't begin to utilize logical thinking until they reach the concrete operational stage between ages seven to eleven (McLeod, 2018). My intention for this project is to provide participants the opportunity to expand on their thinking when discussing how human trash hurts our environment within storm drain pollution. Although children at the preoperational stage may be restricted from logically connecting the consequences of human behavior, I believe my project will provide them the opportunity to think in more advanced ways that may help prepare them for the next stage of cognitive development. In introducing logical thinking to my participants, I hope participants will be challenged to consider their own egocentric behaviors and how it affects their community.

Piaget's theory of cognitive development explains how children can develop and construct their knowledge as they grow throughout childhood. Considering that the participants of my project fall within the stage of preoperational thought, I will utilize their skills of symbolic thinking to help them develop a stronger understanding of the water cycle. My project will also encourage children to begin logical reasoning in how human-induced pollution hurts our environment. By allowing participants the opportunity to use their symbolic thinking skills and by introducing logical thinking, they will begin developing more advanced cognitive skills to prepare them for the next stage, concrete operational thought.

Consideration of Diversity

The Hollister Presbyterian Cooperative Preschool requires donated time and financial obligations from the family. For a child to enroll, there is a single $150 enrollment fee along with a monthly tuition cost that depends on how many days a family wishes their child to attend class. The tuition ranges from one class a week at $80 a month to five class days a week at $400 a month. Also, the child must be two years and eight months old at the time of enrollment, potty trained with all required immunizations. The cooperation of parents and families is mandatory, which includes the commitment to one in-class workday a month and nine volunteer hours. When considering the costs and required involvement, parents who have the means to pay the tuition and also possess free time to work within the classroom are considered compatible families for this preschool.

My participants for my activities include Ms.Kelly's class. Kelly Hacker has been a teacher at this preschool since 2005 and explained that her group of kids this year is much different than in the past. She said the youngest student is three and her oldest is five. It is a mixed group of 15 students in which Kelly explains has created an interesting dynamic. She finds that her older students have taken modeling roles towards the younger students in the class. Considering the mix of ages and abilities, she explained that it could be difficult for her to challenge her older students in the class. It was also brought to my attention that all three classrooms at the preschool are mixed ages since the preschool accepts enrollment all year round. I do not expect the children from Kelly's class to be any different in comparison to the entire school because of the mixed groups of children in all classrooms.

Some of the younger children in Ms.Kelly's class may struggle to understand the content as some of the science language can be a bit advanced. Kelly brought to my attention that the younger students also struggle to sit at the circle for long periods. I also believe it may be difficult for younger participants to comprehend storm drain pollution and its impact on the environment. Understanding the consequences of human behavior on the environment is a complex idea that requires logical thinking that younger children may not have the ability to do. I also believe my group can be impacted depending on how many days a week each of the children attends. My activities will occur in two separate days, which would mean a child may miss an activity or story if they are not enrolled full time. To address the concerns of immaturity within my participants, I will ensure to simplify the vocabulary and main ideas that are appropriate with this age group. For instance, rather than teaching the children the complex vocabulary of each stage (i.e. precipitation and condensation), I focused more on the process of the five basic steps of the water cycle. In teaching this idea to older children, the use of symbolic thinking within the shaving cream cloud activity wouldn't need to be addressed since symbolism isn't as heavily utilized beyond the preoperational stage of cognitive development.

Learning Outcomes

I intend to implement a two-day lesson plan explaining the basic knowledge of the water cycle and its impact on storm drain runoff pollution to the children within Ms. Kelly's class at the Hollister Presbyterian Co-op Preschool.

By the end of the two days, participants will:

1. identify two elements of the water cycle.
2. indicate two ways rain influences the environment.

3. indicate two ways storm drain pollution impacts our environment.

Method

Day 1

First, I introduced myself to the class. Then, introduced a poster board to the students. I explained that we will be learning about the journey of a raindrop and then discussing what we learned. I then introduced the term "water cycle" to the children by saying that it "shows us how water travels from the sky down to Earth." For this lesson, I utilized a poster board to help demonstrate the water cycle visually to the students. On one half of the poster, I placed removable cards that displayed each phase in the water cycle and the other half had a blank area to write student responses following the lesson plan. See Appendix A. The story I read to the children is "The Little Raindrop" (Grey, 2014) which explains the journey of a small raindrop traveling through the water cycle. As I read the book, I ensured to add the card onto the poster in line with the narrative of the story. Introduction to the topic took 2 minutes and reading the story took 7 minutes.

Following the story, I challenged the children aloud as a class, to help me remember the stages of the water cycle. I then removed the markers to return to a blank diagram. I would ask while pointing to the stage, "where does the raindrop start his journey?" As children say aloud their responses, I placed the card in the location they believe it belonged to while also guiding them when they needed assistance. Completing the diagram again took about two minutes.

I then began the documentation of their responses. I asked each student to share aloud what they learned from the water cycle and then wrote their responses in the blank area. For children who had difficulty remembering or thinking of something, I guided them to the water

cycle images on the poster board to help with remembering and also by asking open-ended questions. I ensured to write their responses to the documentation area of the poster.

At the end of the lesson, I sent home a project for children to try at home with their families. The project was a “make your own water cycle” bag that included instructions. This take-home project prompts students to seal water in their bag and to place on a window that has direct sunlight. Over time, the children will witness the water cycle as learned in class and share their knowledge with their families. See Appendix B.

Day 2

As children began arriving at class, I asked children to join my morning activity table. At my table, I had three glass jars with three-quarters filled with water. In addition, I filled the remaining space of the jar with shaving cream. The shaving cream represented clouds within the water cycle. I also included three additional cups with water mixed with blue food coloring. This blue water represents the rainwater within the water cycle. Included with the blue water were plastic pipettes for the children to distribute their raindrops. For an image of materials used, see Appendix C. In this activity, children were encouraged to make their cloud “heavy enough to rain.” The children did this by dropping raindrops on the cloud until it was heavy enough to fall like rain. While children were independently making their “rain in a jar”, I ensured to ask open-ended questions that helped them reflect back to day one when we learned the water cycle. Some questions I asked included: “why is the rain falling from the cloud?” and “how does the rain get to the cloud?” When children had difficulty remembering, I ensured to have my water cycle diagram on the table for the children to use as a guide. Each

child had about five or more minutes to experiment with their “rain in a jar” during table activities in Ms. Kelly’s class.

After morning tables, children transitioned into circle time. During circle time, I presented my poster board. On this poster board, the top had photos of local water drains, the middle had examples of garbage, and the end had an empty space to document children’s answers. See Appendix D. The images I posted are of an actual storm drain found at a local Target. I asked aloud, “does anyone know what this is a picture of?” After a child answered, I then asked the class, “does anyone know what storm drains are for?” If no child responded, I tried to probe for responses by reminding them what we learned about the last class (i.e., day one). The introduction of drains with the use of photos took six minutes. I then transitioned into the story All the Way to the Ocean (Harper, 2006). This narrative story explained how water run-off pollution occurs and how it hurts our environment. Reading the story took me five minutes. I then transitioned back to the poster board where I included images of examples of garbage that can be found in storm drains. I asked the children aloud “what are some items you guys recognize on this poster?”

I then began reflecting on the content learned and documented their answers. Some questions I asked were: “why is it bad that garbage is getting in the drain?” and “how does garbage get there?”. The documentation took an additional six minutes. I then concluded the discussion by asking the children what they would do to help this problem. I offered suggestions when children didn’t respond by saying, “how could we teach others about this problem?” I then thanked the kids for learning with me about the water cycle and storm drains. Each child received a sticker as a reward for their participation.

Results

Learning outcome one was that participants will identify at least two elements of the water cycle. On day one, participants displayed their knowledge of the stages by completing the water cycle diagram with the removable cards. The five elements discussed in my presentation included the sun, condensation, precipitation, collection, and evaporation. I was able to test each student's knowledge as there were only eight children in the class that day. Ms. Kelly's class was collectively successful in identifying all five stages of the water cycle as described in the book. Based on my findings, it seems that children had trouble understanding evaporation and the sun's role in this process. Only one child out of the eight in the class was able to identify the evaporation stage correctly and how it occurs. In addition, all eight participants understood when precipitation occurs. Since the children were able to identify each element of the water cycle collectively as a class, participants successfully met the first learning outcome. See Table 1 for details.

Learning outcome two was for participants to indicate at least two ways rain influences the environment. In Figure 1, I have provided a photograph of their responses after having read about the water cycle. For day one, there were eight children participating. Participants came up with a total of seven different influences rain has on their environment. Only one child identified that the sun's heat creates clouds within the evaporation stage. Five students claimed that rain falls on plants and three students referred to "roots drinking" the rainwater. I also found that four participants shared that rain creates mud despite the fact that it wasn't discussed in the book. Since participants were able to come up with more than two influences rain has on the environment, the learning outcome was met. See Table 2.

Learning outcome three was for participants to indicate at least two ways storm drain pollution impacts the environment. In Figure 2, I have provided a photograph of their responses after having read about storm drain pollution. In total, the class came up with seven different ways of how storm drain pollution impacts the environment. Half of all participants identified that fish get injured or ill when trash travels to bodies of water through drains. Five participants explained that trash ends up going down storm drains whenever it rains. Only one child stated that drain pollution can hurt us because water gets dirty from the trash that reaches the ocean. Since participants indicated more than two ways storm drain pollution impacts our environment, outcome three was successfully met. See Table 3 for details.

Discussion

In my opinion, I believed my presentation was a success as all three outcomes were met. My first outcome was that the class would successfully identify two elements of the water cycle. My results indicated that the class was capable of indicating all five stages discussed within my presentation. The second outcome was for the children to indicate two ways rain influences their environment. With the exception of several duplicate answers, the class identified seven different ways rain impacts their environment. Finally, the last outcome of my presentation was that the class would indicate two ways storm drain pollution impacts their environment. My results displayed that the class was capable of identifying seven different impacts storm drain pollution hurts the environment.

Although the number of participants was drastically different between the two presentation dates, Ms. Kelly's class demonstrated their understanding of both important topics: the rain cycle and the impacts of storm drain pollution. I found that participants

struggled to understand the sun's purpose through evaporation. Results displayed that only one participant out of the eight was able to accurately explain the sun's role within the process of evaporation. On the other hand, children showed an understanding of how garbage in drains injure fish and other marine life. During the discussion, they also demonstrated their understanding of the human impact of garbage within the environment as they argued that garbage only belongs in trash cans.

In accordance with Piaget's cognitive developmental theory, the children were capable of using objects symbolically to identify the process of the rain within my "rain in a jar" activity. Children recognized that the fluffy shaving cream within their jars signified the clouds within the sky. Children began discussing that their clouds would get significantly heavy resulting in blue rainfall within their jars. Some even began suggesting that there was a "storm" in their jar as they squeezed significantly more water onto their cloud. Although my participants are within the preoperational stage of cognitive development, they demonstrated their ability to practice logic which is typically utilized in the following stage (i.e concrete operational stage). Half of the participants claimed that fish get sick from garbage left by humans. Children further elaborated that they can be heroes for the fish by teaching others about what they learned about storm drain pollution. The connections participants made further elaborates on the logic they utilized in understanding how human involvement, like pollution, impacts our environment.

If I were to complete this presentation again, I would try to utilize another form of documentation or display. I found that the posters were a bit difficult to display as children struggled to see from afar or grew distracted by elements on the poster. I would also try to ensure I had the same amount of participants both days. Many students were absent on the

first day when I discussed the water cycle. In turn, students who were not there the first day had trouble connecting the purpose of the "rain in a jar" activity. Finally, I would also consider utilizing some sort of media like a video or song in relation to the topic. I found that the children had trouble sitting through the discussion when everyone had a turn to share. By including a media source, it could help maintain the children's focus or help in getting "the wiggles" out. Nonetheless, I believe children within early childhood are capable of learning such complex concepts within science education that could benefit their learning later down the road. Children within Ms. Kelly's class learned the basics of the water cycle and the environmental impacts caused by storm drain pollution.

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Table 1

Elements of the water cycle

Element/Stage	# of children who identified stage **correctly**.	# of children who identified stage **incorrectly**.	# of children who **didn't respond**.
Sun: Provides heat onto the planet that encourages evaporation.	**1** of 8	**1** of 8	**6** of 8
Condensation: Water collection within the clouds.	**3** of 8	**1** of 8	**4** of 8
Precipitation: Rain falls from clouds when clouds get "too heavy".	**8** of 8	**0** of 8	**0** of 8
Collection: Fallen rain collects in rivers, lakes, and oceans.	**6** of 8	**0** of 8	**2** of 8
Evaporation: Heat from the sun turns water into a vapor that floats into clouds.	**1** of 8	**2** of 8	**5** of 8

Table 2

Ways rain influences the environment.

Participants' answers	**# of answers N = 8**
Sun gets ***hot*** and makes ***water float***.	**2**
Water goes ***into clouds*** because of the ***Sun's heat***.	**1**
Rain falls on ***plants*** (grass/flowers).	**5**
Roots from plants ***drink rain to grow***.	**3**
Rain ***makes mud***.	**4**
Rain collects into ***oceans and rivers***.	**3**
Cold places have snow instead of rain.	**2**

Table 3

Ways storm drain pollution impacts the environment.

Participants' answers:	**# of answers N=12**
Garbage in lakes and oceans will ***hurt fish/fish get sick***.	**6**
Food/Wrappers should not go into drains.	**4**
Storm drains ***lead to oceans, lakes, and rivers***.	**2**
When it rains, ***water/garbage goes down the drain***.	**5**
Storm ***drains are everywhere***.	**2**
We swim in oceans - ***garbage can hurt us***/***swimming in dirty water***.	**1**
Garbage belongs in trash cans.	**4**

Figure 1

Results of participants' answers on how the water cycle influences our environment.

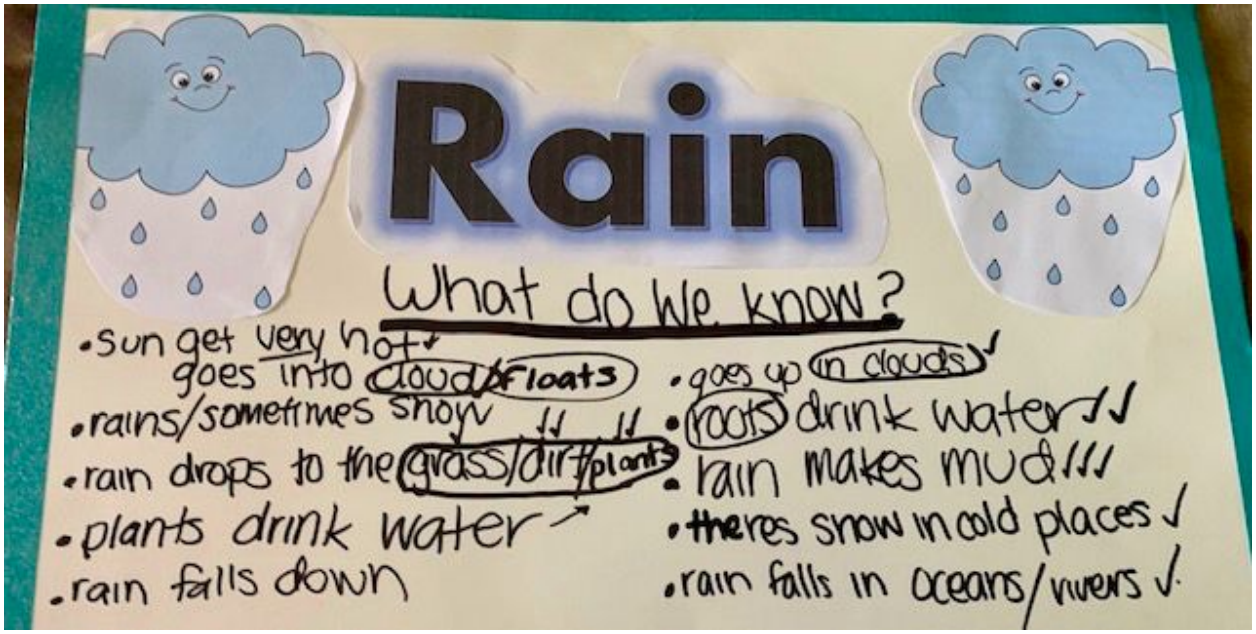
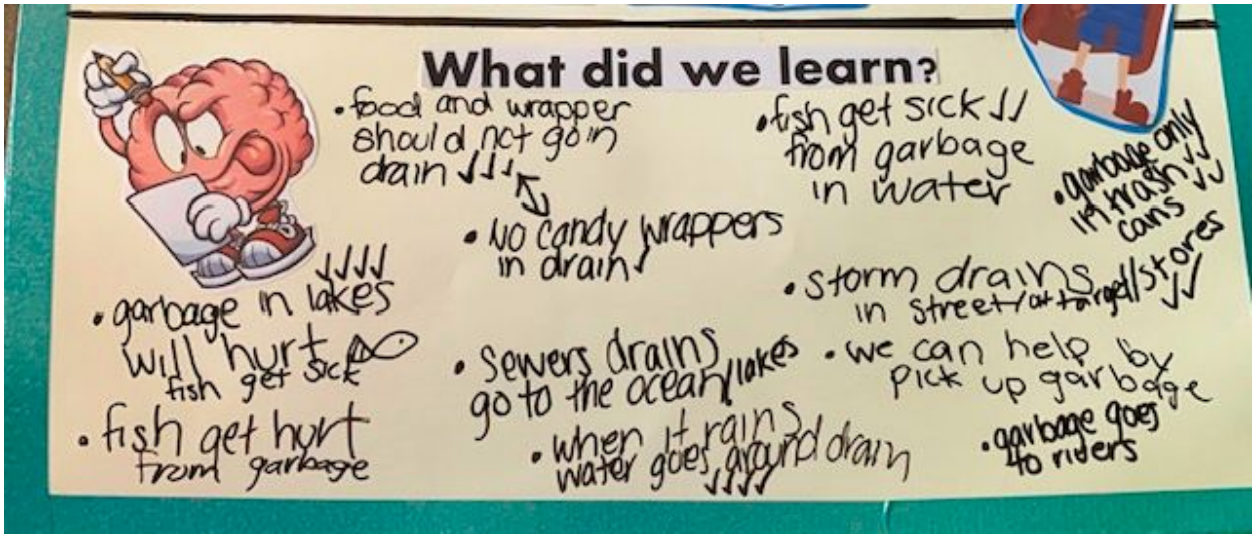


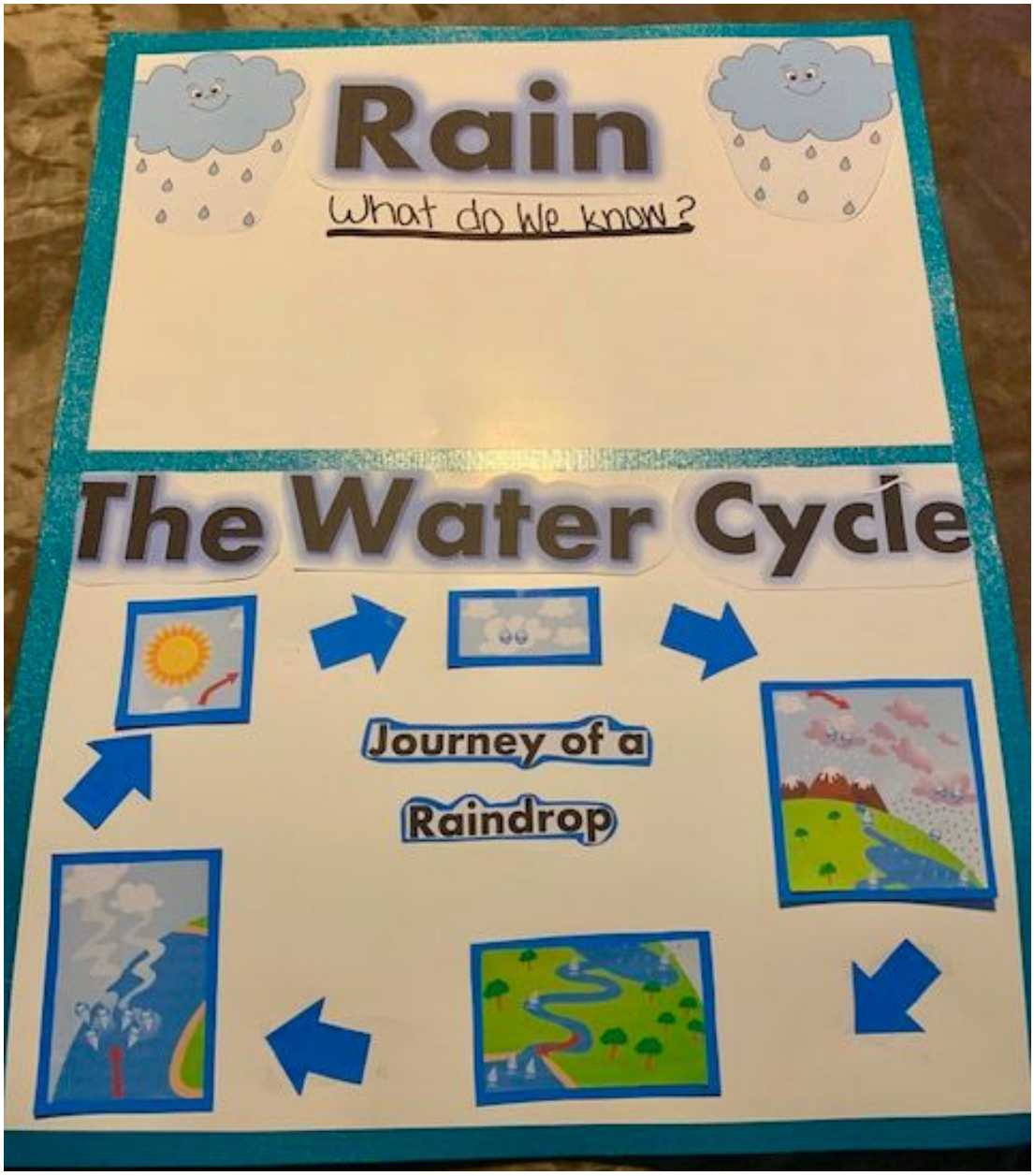
Figure 2

Results of participants' answers on how the storm drain pollution impacts our environment



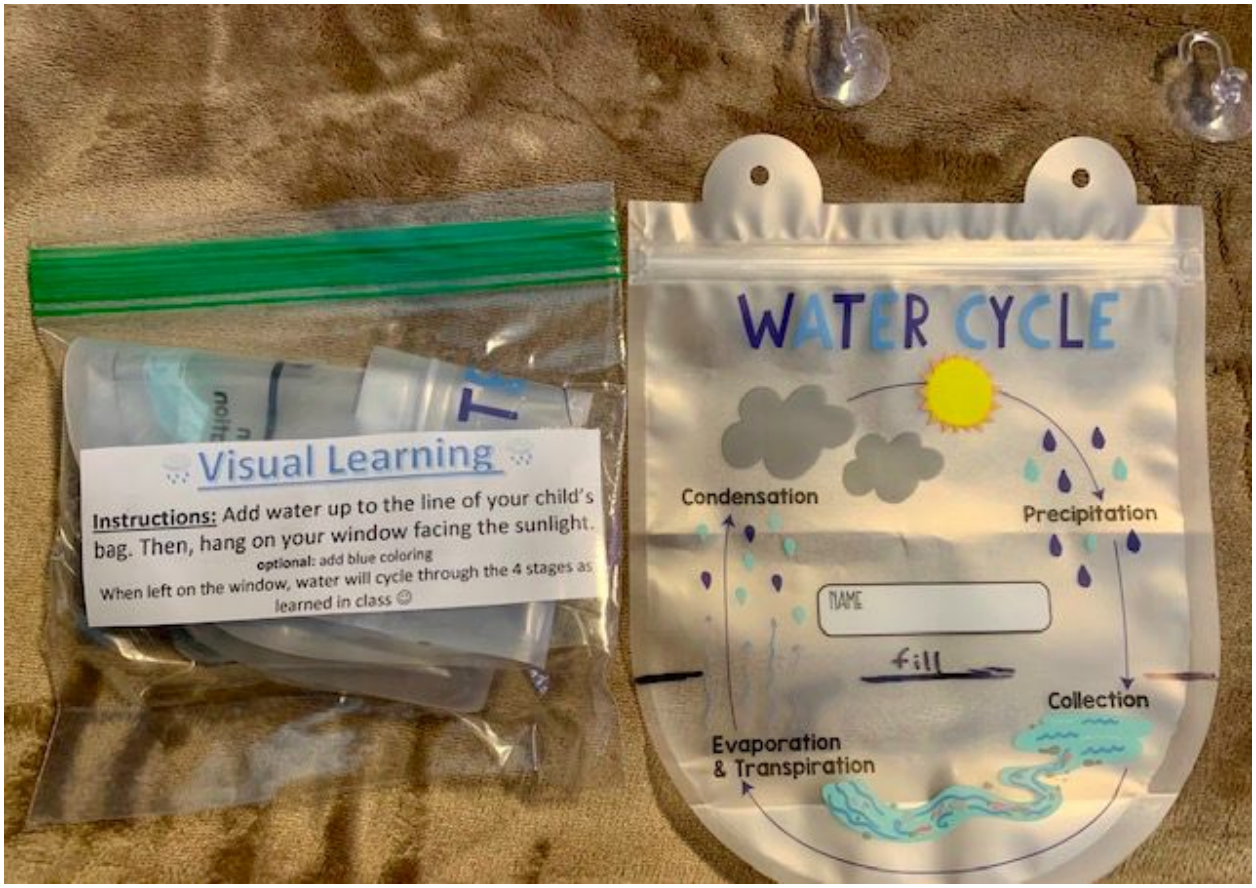
Appendix A

Poster utilized to present material to participants about the water cycle



Appendix B

Take-home activity given to students

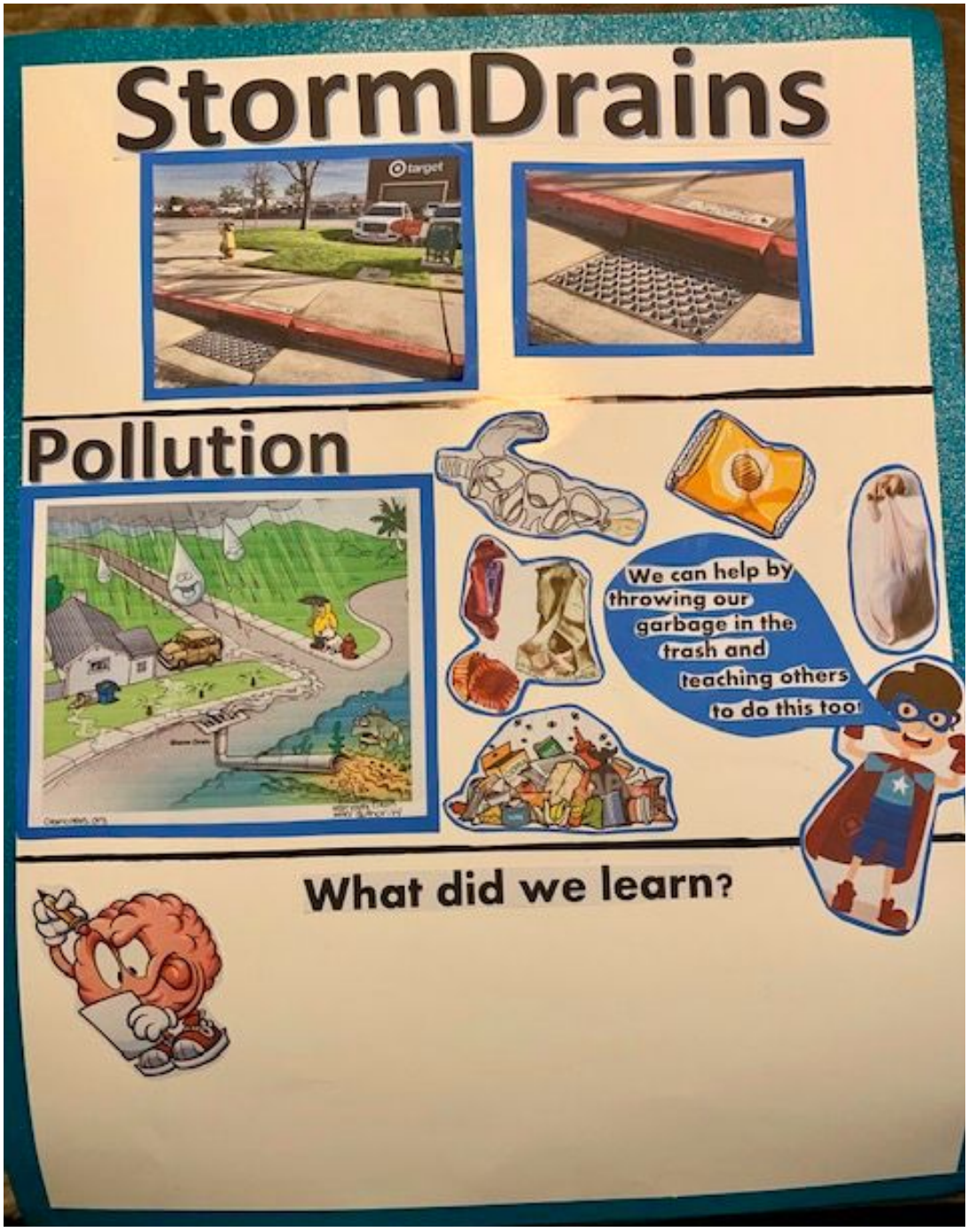


Appendix C

Materials required for "Rain in Jar" activity

Appendix D

Poster utilized to present material to participants regarding storm drain pollution


StormDrains
target
Pollution
We can help by throwing our garbage in the trash and teaching others to do this too!
What did we learn?