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The Importance of Hands-On Science: an Exploration of Scientific Experiences in and Outside of the Classroom

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Abstract

This paper focuses on approaching science education through a lens of hands-on learning. Through observing different teaching environments that allow for this hands-on learning to occur, I hope to shed light on the importance of teaching through exploration, forming connections with nature, and allowing children to find a love for science. Children are naturally curious, experimenters, creative, and passionate and learn when these characteristics are met. Science has similar characteristics. Science is all around us. It focuses on inquiry, discovery, and connection. It is in the air we breathe, it occurs naturally without us having to manipulate it. Through centering learning on this kind of practice, children will enrich their learning through interaction and the ability to make science learning approachable. Children deserve the time and space to play, be outside, discover, and question. Through teaching science through an inquiry lens, children will continue to learn holistically and see the whole parts of learning. These are all key components of a hands-on science curriculum, and children deserve the opportunity to experience it.

Dedication

Dedicated to all the children I have met who show how discovery and exploration are essential in shaping all aspects of learning and to my future students who will do the same.

Acknowledgments

Sarah Lawrence College is a special place, a community that I am beyond lucky and proud to be a part of. I chose Sarah Lawrence because of The Art of Teaching Program and I am beyond grateful for this experience, for the lasting connections, development of my pedagogical beliefs, and growth as an educator. I would like to thank my teachers, professors, family, and friends. I would not be here without the support from you all, thank you so much for everything you have done for me. Pam, thank you for your compassion and dedication in showing the importance and need to offer a diverse array of literature. Denisha, thank you for teaching us that despite the complexities of the educational system, we must come into the classroom with compassion and love for all students. Farrah, you reshaped my relationship with math, by emphasizing the importance of reflecting on the process instead of the answer. Thank you for centering our course on these whole-child approaches toward math. Genny, thank you for allowing us to do hands-on science learning in our class, and for seeing the value in providing readings, and discussions on this kind of science learning. Cassandra, thank you for showing me how to foster community, compassion, self-expression, and care in your classroom and our smaller moments together. You have shown me what enjoying your job should look like. Lorayne, thank you for bringing your smile and laughter to all that you do. Thank you for your work in continuing to believe in progressive play-based education and allowing children to be able to play, be in nature, and have autonomy. Thank you for recommending that I be placed with Evangelyn as her assistant in the four fives class, and for all of the special memories that came from it.

Emily, thank you for all of your guidance and continued support throughout this last year. It has been great getting to work with you and I appreciate the kindness, flexibility, and time that you continue to provide.

Liz and Christine, thank you both for making me feel part of your classroom, for your continued support, and for your feedback throughout my time at Ella Baker. I have learned so much from you; such as creating a classroom environment that fosters compassion, making modifications to make lessons age-appropriate, and generating a space for creativity and connections to flourish.

Kori and Jenn, thank you so much for welcoming me into your classroom, and for all of the time and support you have given me. You have shown me how to meet children where they are developmentally, teach from a place of compassion and love; and allow children the space and time to explore, play, make mistakes, use their creativity, and find purpose in their learning.

Evangelyn, thank you for making my first year of The Art of Teaching Program transformative and special. I appreciate you taking me under your wing, giving me space in your classroom, creating an encouraging and loving space, and supporting me throughout my time in this program. You showed me every day the importance of knowing students' strengths and interests, being flexible, and the importance of creating a classroom environment founded on trust, kindness, and community. I am grateful for all of the small moments of glances and check-ins throughout the day and for our friendship. Rue, from doing our first recollection on visibility, you have taught me to teach through observation of children's strengths and interests. You have taught me so much, and have provided such rich literature and class discussions, that I will continue to reflect on throughout my educational career. Thank you so much for helping and guiding me throughout my entire time in The Art of Teaching Program, I appreciate all that you do. To my cohort, thank you for helping to create such a close-knit community. From our lively,

interesting discussions, I hold many of your anecdotes and ideas that I plan to bring into my teaching. I appreciate you all and am so proud of you! Thank you to my grandparents for all of your love, support, and wisdom. Lastly, I would like to thank my Mom and Dad for the abundance of love and continued support throughout my five-plus years at Sarah Lawrence. You both can always find the words I need to hear at the right time, which I hope to do for my students.

Annotated Outline

Thesis Statement: The purpose of this thesis is to show how children should learn science through play and exploring with nature, that it is essential to allow children opportunities to form their conclusions through collaborating with others, and how children's creativity and passions can be enhanced through adopting a hands-on science approach towards teaching science.

1. **Introduction**

- Teaching science from narratives of our own experiences/experiences of students
    - Quick guided breath to ground ourselves
    - "There is the beauty and the wonder of the world that is discovered through the results of these new experiences" (Feynman, 1966, p. 11).
    - Overview of contents of this presentation
        - Recollections of Nature and Science
        - Introduction and Purpose of Hands-on Science Learning
        - The relationship between Hands-on Science and Nature
        - Making Science Learning Approachable
        - Recommended Practices- Where do we go from here
- Personal Recollection of Nature and Science in My Life
    - Nature recollection
        - Early childhood experiences with science and connections with nature
        - Conducting hands-on science learning without realizing it
    - Science recollection
        - Science becoming standardized
        - Shift to enjoying science from Sarah Lawrence

- Food, Agriculture, Environment and Development with Joshua Muldavin
- Emergent Curriculum Core II with Genny Ward-Wernet

- Hilltop Hanover Farm
    - Inspired by taking Joshua Muldavin's course Food, Agriculture, and Development to work at a sustainable farm Hilltop Hanover Farm in Westchester, New York
    - Being on a farm manual labor is an intentional practice that does not harm the environment
    - Working closely with native species of operating as a whole cohesive community of working together, feeding cows and goats
    - Community space showed me what being in a community is like

2. Introduction and Purpose of Hands-on Science Learning

- Purpose of my thesis
    - Science learning should be focused on student's interests and needs
    - Science is more than just in the classroom
    - Science evolves with us and helps shape us
- Why the Hands-on Approach?
    - The time children get to experiment, hypothesize, be encouraged to ask questions and be actively engaged and involved
    - Interdisciplinary nature of science
    - Time for children to be off their feet, freely exploring the classroom, mixing powders and liquids together

- Time for all voices to be heard, independent time for researching/forming conclusions
- Demonstrates the importance of the process of finding the result!
- Teaching science from narratives of our own experiences/experiences students
- Hands-on science learning is playing with and manipulating materials, with the central focus on observing and being immersed in the scientific process; it also is "the result of many interpersonal exchanges, of interactions with materials…" which can be further discovered through collaboration (Gallas, 1995, p. 14).

3. The Relationship Between Hands-on Science and Nature

- The importance of acknowledging how indigenous tribes have and continue to provide harmonious relationships with nature and have practices that should be learned from. Robin Wall Kimmerer, *Braiding Sweetgrass* does just that.
  - Kimmerers journey through having to prove her native beliefs of botany to science professors at the University
  - "But then I learned to fly. Or at least try. It was the bees that showed me how to move between different flowers—to drink the nectar and gather pollen from both. It is this dance of cross-pollination that can produce a new species of knowledge, a new way of being in the world. After all, there aren't two worlds, there is just this one good green earth" (Kimmerer 2013, p. 47).
  - Asters and Goldenrod chapter title
    - Existing collectively

    - "Roger Hart (1979) found that children spent long stretches of time simply watching wildlife. And their careful observations led to expert knowledge" (Crain 2003, p. 3).
        - Children bringing in stuffies many are animals
        - Bringing in non-fiction literature and sharing facts about animals, the habitats-community found from the strong care for animals!
- Wonderforest Nature Preschool
    - Play in nature can improve motor skills (Fjørtoft 2001), increase cognitive functioning and attention capacities" (Kuo and Faber Taylor 2004; Pretty et al. 2009; Wells 2000), cited by Derr and Lance, 2012, p. 113).
    - Play and nature as one
        - Tactile play inside the classroom
            - Mud kitchen
            - Painting
            - Forest green space that allows for physical movement and play
        - Outside
            - Explorations to Prospect Park
            - Neighborhood walks/community garden visits
    - Creates opportunities for children to further their creativity, delve into their interests, and get messy!
- Early Childhood Center 4-5's Evangelyn's class
    - Meshing of outside and inside of the classroom (books, digging, dancing, exploration

    - Collaborating with the extended community through visits from CURB (Center for the Urban River at Beczak)
    - Given time to explore
        - Knowing student's interests and passions
        - Providing space for inquiry and exploration
    - Mess is embraced and encouraged through hands-on learning activities and play outside

4: Making Science Learning Approachable

- Creating opportunities for hands-on science learning to happen

- Brooklyn New School Recollection Science in Jenn and Kori's Kindergarten ICT Class
    - Support and Nurture for hands-on science learning
    - Swimmy (turtle class pet)
        - intentionally placing items so students can access them
    - Shore curriculum
        - Time for this learning to happen!!
        - They embrace chaos and the messes that come from this rich learning!
    - Science occurring naturally
        - This comes naturally to children and they need the space to be able to explore it
        - Teachable moments that are built off of this creativity
            - Ajani making a fishing rod
            - Pepper drawing her organs in her body
- Ella Baker Recollection Recollection in Liz and Christine's class Third Grade ICT Class

- Cooking every Friday for work time
  - Measuring
  - Mixing
  - Making homemade butter and seeing the process of heavy cream turning from a liquid to a solid
- Science integrated through having a sea creature project
  - Museum of Natural History, New York Public Library for research
    - This shows how hands-on science learning is not only in the classroom or outside
    - Creative projects through sewing, painting, and creating a sketch about their sea creature
    - Creating opportunities for children to connect with nature
- “Most children are willing to work hard, hard-eager to work hard-so long as they're excited about the things they're working on" ((Resnick 2017, p. 70).

5: Recommended Practices- Where do we go from here

- Knowing students in science curriculum and lesson-making
  - Evangelyn four-fives class
- Bank Street *Teaching Kindergarten Conference: Where Did the Garden Go?*
  - Using collections with science The Art of Gathering: Explorations with Found Objects (Maria Richa)
    - Collecting shells at the beach
    - Collecting leaves, feathers, rocks, and loose bark from a walk at the park

    - Into the Garden: Love, Joy, and Nature in the Kindergarten Classroom and Beyond by Liat Olenick and Tom Roderick
        - "Finding nature all around/stumbling into nature" (Olenick, 2024).
        - "Ground in love, community and care" (Bank Street, 2024).
- New York State Science Standards
    - Adapting/tailoring lessons to go along with these standards
    - Interdisciplinary lessons that relate to other subjects
        - Science
        - Literacy/ELA
        - Mathematics
- Future Scientists
    - "I'm a scientist for real, I go on adventures" (Jack, 5 years old, Brooklyn New School).
    - Continuing to support children's joy for observing and what meaning comes from it
    - Importance of focusing on positive and amazing science learning that is happening and using this drive to continue to teach science this way

"Children interested in butterflies may, for example, be first attracted by their colors or their movements (essentially their esthetic qualities); later;-by questions posed, by the interests of others, by closer observation, they become interested in their life cycles, periods of dormancy, and activity. Such interests could go in many directions, even beyond butterflies" (Perrone, 1994 p. 28).

Process Paper

My love for science learning began when I was a child through forming deep connections with plants and animals by playing outside in my backyard and from being best friends with my dog Bonnie. Looking back at my early elementary schooling, I felt connected during science time. I remember how the second graders at my school were in charge of tending to a small garden courtyard. All the children in my class were assigned a partner and a day of the week to go outside and water the plants. When it was my day I raced out of my classroom and was in awe of all of the vibrant flowers around me, and greenery. I felt at home and safe. My fifth-grade class also had a garden, and sometimes during recess, I would sneak away from the playground and go see the garden. It had a few wooden beds, and a wooden fence enclosed the garden. I remember staring at the wood fence feeling relieved that the plants were going to be safe and able to keep growing.

However once I was exposed further into the systems of public school, my association with science shifted downwards. Starting in middle school science learning became standardized, forming hypotheses and finding answers, sometimes in place of experimenting depending on timing. I still enjoyed learning in my science classes, but once we had lab work I became anxious and uninterested. All of the information I had been absorbing and engaging with seemed distant, and the skills that I was being assessed on were more technical and specific, it allowed very little room for error or confusion. I would gaze out to the microscopes with hopes and curiosities that I wanted to further explore but were not possible unless they were written on my packet or if I finished the lesson early. These negative experiences with science, unfortunately, continued to follow me and got even more severe throughout high school. From higher expectations to learning for state exams, hands-on science learning fizzled out.

My deep connection with science was rediscovered at Sarah Lawrence. After completing the Food, Agriculture, Environment and Development course with Joshua Muldavin, in the fall of my junior year. From the first lecture, I felt fully immersed and eager to learn more about food systems and scientific procedures. Joshua emphasized continuing to stay curious, question, and conduct our own research to find out about the world. For the first time since elementary school, I felt supported and part of a community in the science field. Jousha would frame lectures around a series of deep, rich, and complicated questions and he would ask us to think critically about these constructs. At first, I felt overwhelmed and confused with the readings, but Joshua reassured me that it was part of the process. That these systems and corporations are meant to be confusing, and that our role is to try and take them apart and make sense of these policies through a lens of activism and human rights. My confidence as a student continued to grow throughout the semester, and my nerves and hesitations turned into vocalizing my thoughts and forming deep connections with classmates and with Joshua.

When I began my research, I looked back at Emergent Curriculum II with Genny Ward-Wernet. I was inspired by our first assignment of writing a science recollection and found my thesis emerged from this assignment. Without fully realizing it I highlighted how hands-on science learning was the key to me enjoying science when I was in elementary school and how this was heightened further by my love for nature as a child. Genny structured her course to allow time to conduct our own science experiments by interacting with the various materials she would bring in. The first time she instructed us to play with the materials, I became overwhelmed with the amount of materials and all of the possibilities. I had to switch my previous experiences of science learning in middle and high school, to freely using materials and having the ability to use my creativity. These unstructured opportunities at the beginning of class acted as a reminder

of how different children will interact with an activity that is less structured and has many choices, and to be cognizant of how all children approach these learning experiences differently and will get something different out of it, and just how special that is.

My student teaching placements and other teaching experiences helped lead me to see how hands-on science learning can exist in the classroom. My host teachers have shown me that implementing hands-on science learning can require creative modifications for lessons, and still needs some structure and guidelines for children to follow. Through this careful and intentional planning, I have observed in public progressive schools and private schools, just how far this kind of learning expands to. Teaching from a perspective that welcomes and whose main purpose is to engage children at all levels of learning to get to play with materials and establish their own understandings, and curiosities is why so many children who experience this kind of learning continue to pose their questions and maybe inch a little bit closer or sit up taller when they hear that they have science that day.

I have found that the process of completing this thesis has been a journey of finding balance. I have questioned many thoughts and ideas throughout this thesis, through reconfiguring and piecing together the main purpose of my thesis. I struggled while drafting my outline, how to take the plethora of quotes I have accumulated, and make sense of them. This process of culminating theory, rich texts, and my own work and personal experiences has made me trust myself and know that I have the knowledge, experiences, and passion to share about this important, abundant, and complex topic that is hands-on science learning.

Science is a process. It is a system that requires exploration, problem-solving, collaboration, playing, reupholstering, and love in order to function. All these characteristics of science occur naturally in nature. If these systems are how organisms thrive and live, why are

many public schools teaching this learning with a barrier between the connection and the content?

I focus this thesis from the perspective of the abundance that hands-on science learning offers. The current education system tends to highlight implementing new curriculums that center on standardizations and "grade level" achievement. To combat the very real and challenging aspects of being an educator, this thesis instead highlights all of the amazing opportunities and resources that this process of science education has to offer. This thesis speaks of visual learning experiences and heavily draws from my student teaching experiences at The Early Childhood Center in a four-five classroom, Ella Baker in a third-grade ICT classroom, and Brooklyn New School in a kindergarten ICT classroom. I believe these observations paint a clear picture of the benefits of implementing hands-on science learning and all of the possible outcomes that can emerge.

One of my hopes is for this thesis to allow us to take a breath, step back, and see all of the incredible ideas, creations, and ideas to emerge from this work. Finding balance using theory referencing important concepts and using my own experiences in my student teaching and other experiences can help ground and continue this needed conversation of implementing hands-on science learning.

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Hands-on Science Resources

Science Literature

-Hauser Frankel Jill. *Gizmos & Gadgets Creating Science Contraptions that work (& knowing why)* by
-*Creative, Hands-on Science Experiences Using Free and Inexpensive Materials* written by Jerry De Bruin and illustrations by Charlene Czerniak
-*Pop Bottle Science 79 Amazing Experiments & Science Projects* by Lynn Brunelle
-*Hands-On Science Over 40 Fantastic Experiments Sound and Light* written by Jack Challoner and illustrated by David Le Jars
-*Teach for Climate Justice: A Vision for Transforming Education* by Tom Roderick
-*Integrating Science With Reading Instruction Grades 1-2 (Hands-On Science Units Combined With Reading Strategy Instruction)* by Trish Callella and Marilyn Marks
-*Junk Drawer Geometry: 50 Awesome Activities That Don't Cost a Thing (4) (Junk Drawer Science)* by Bobby Mercer

Nature Literature

-*Beyond Ecophobia-Reclaiming the Heart in Nature Education* by David Sobel
-*How To Say Hello to a Worm: A First Guide to Outside* by Kari Percival
-*Mii maanda ezhi-gkendmaanh / This Is How I Know: Niibing, dgwaagig, bboong, mnookmig dbaadjigaade maanpii mzin'igning / A Book About the Seasons* by Brittany Luby
-*Healing Breath: A Guided Meditation Through Nature for Kids* by William Meyer
-*Messing About in Science* from The Informed Vision: Essays on Learning and Human Nature. Agathon Press, 1974. by David Hawkins
-*Hiking Day* written by Anne Rockwell and illustrated by Lizzy Rockwell
-*Wild Child* written by Dara McAnulty, illustrated by Barry Falls
-*Snow Birds* written by Kirsten Hall and illustrated by Jenni Desmond
-*I Am the Seed that Grew the Tree* selected by Fiona Waters, illustrated by Frank Preston-Gannon
-*The National Gardening Association Guide to Kids Gardening*
A Complete Guide for Teachers, Parents, and Youth Leaders by Lynn Ocone with Eve Pranis
-*175 Amazing Nature Experiments by* Rosie Harlow and Gareth Morgan
-*Classroom Activities for a Better Environment-Worms Eat Our Garbage* by Mary Appelhof, Mary Frances Fenton, and Barbara Loss Harris

Field Trip Ideas in New York City

New York Hall of Science
https://nysci.org/educators#educatorResourcesSec
Brooklyn Botanical Gardens
https://www.bbg.org/learn/teachers_and_schools
Gowanus Canal Conservancy
https://gowanuscanalconservancy.org/communityscience/
Oko Farms: Group Farm Tour
https://www.farmschoolnyc.org/resource-hub

GrowNYC
https://www.grownyc.org/greenmarket/education
Hudson River PK
https://hudsonriverpark.org/the-park/parks-river-project/science/school-programs/
Exploring parks/local communities

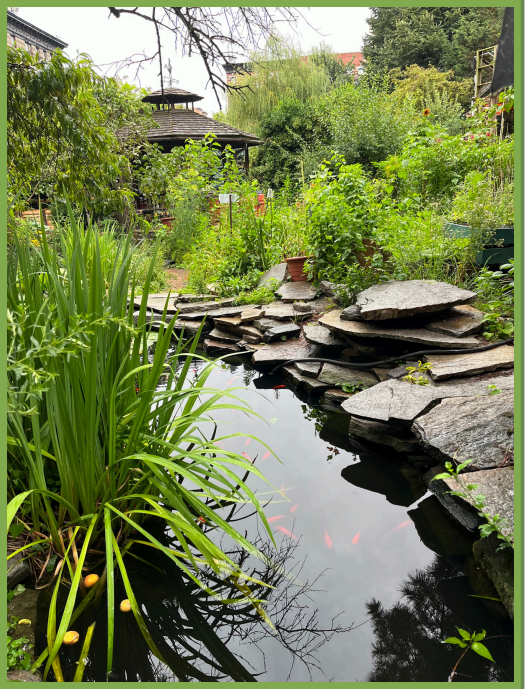
"Children have an opportunity to bond with the natural world, to learn to love it and feel comfortable in it, before being asked to heal its wounds" (Sobel 1996, p. 10).

Good morning everyone. I am very glad to be speaking with you all today. This presentation is about hands-on science learning (say title)
Before I begin this presentation, I would like to take about twenty seconds to do 1 cleansing breath with you all to ground us before I begin. I'm going to ask anyone who feels comfortable to participate in taking this breath, you can close your eyes if you would like. We'll breathe in then breath out. Great, now I feel grounded and ready to dig into everything!

“

There is the beauty and the wonder of the world that is discovered through the results of these new experiences.”

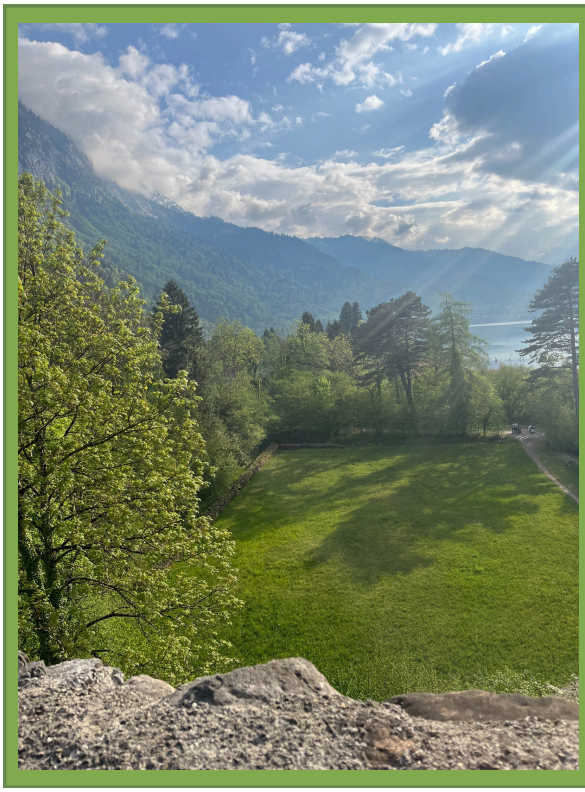
- Richard Feynman, “What Is Science?”



Teaching science from narratives of our own experiences/experiences of students

Here is a brief overview of the contents of this presentation:
1st- Why I choose this topic
2nd- Recollections on being a science learner outside the classroom and inside
3rd- Foundations for how we see project-based science
4th- Student teaching experiences/continued experiences with hands-on science
5th-Conclusion now that we have the context for this approach what are the next steps for teaching science from a hands-on science approach?

edit 3 and 4



Recollections of Nature and Science

My Connections with Nature

Science has occurred naturally throughout my life. As a child, science and nature blended together. Some of my earliest memories I have were outside in my backyard. I would frequently wake up early and go exploring in my backyard. My sister and I would swing on our swingset and look up at the sky, while pumping our feet thinking that with just a bit more chanting we could be flying as high as the birds that were flying around us. Playing outside was a way that my sister and I bonded. I would watch with a careful eye the harmonies of chickadees and blue jays, trees beginning to bloom and I would look up at the sky in awe of everything I was seeing.
At night in the summer we had a family of bats that lived, still live in our attic and on melting summer evenings, we would watch with amazement the bats flying out from our vent and hoovering high and low. Then we would bolt inside to not have to get a rabies shot. Hands-on learning was occurring, and I was allowed to keep exploring.

My curiosities stemmed from what creatures lived in harmony with me like the family of groundhogs, “heagie” was the name we called one of them, (probably all of them at some point), it was from being able to explore nature that my questions would continue to develop.

When I was thinking back about my science experiences. I remembered the power that the science instruction had on my mood at the time, and less on the actual science. My 5th grade teacher Ms. Monteloni would frequently incorporate nature in the classroom.
-shy kid
-my voice came out through being outside

My Science Recollection


Reclaiming what science means to me


Joshua Muldavin's course, Food, Agriculture, Environment and Development


Genny Ward- Wernet's course, Emergent Curiculum II


Science shifting and becoming standardized

My elementary school had a few hiking trails beyond the playground and my teacher told us that we were going to be walking along the trails, and taking notes of our observations. I think we were doing a science experiment about trees maybe. What I do remember is my face lighting up after hearing that we would get to be outside. Once we got to the trail, I immediately ran with my friends to look at the different sized trees, being distraught when one of the trees fell over and smelling the air. The air felt crisp, welcoming and sweet, and I countied to breath in and out not wanting the day to end.I have known in the back of my mind that I have always been drawn to science and nature, but this love and curiosity faded drastically from the rest of my time in school. The shift in my love for science returned from taking Joshua Muldavin's course, Food, Agriculture, and Development. My perception of science learning returned to what it was like when I was a child. Joshua cultivated an environment of questioning everything, while learning about the rich history of agriculture, our relationship with nature and what impact do we have on these things?

Hilltop Hanover Farm


Intentionality working with nature


Observe the nature of different plants growing


Children experiencing this hands-on learning

That summer after taking Joshua's course I worked at a farm in my local community, where I got to experience hands-on learning outside of the classroom through working in the fields, spending hours weeding the beds, planting crops, harvesting on Wednesdays and getting to co-lead tours for visiting students, seeingthe cows and goats, Chayne and Glitter and getting to harvest snap peas with them and getting to see their excitement and amazement of pulling a beet from out of the ground.
I had the strong roots in the importance of nature, and the science piece was further reached through taking Emergent Curriculum Core II with Genny Ward-Werent One of our first assignments was writing a science recollection where we thought back to our experiences with science. It was through this process of reading rich texts that hands-on science was restated and made me realize the interconnectedness of this hands-on learning experiences with creating opportunities for children to further explore, and connect curriculum to personal experiences

-love for nature working at hilltop hanover
-hands-on learning
-seeing progress and growth of relationship between nature and plants
-tomtato plant

Introduction and Purpose of Hands-on Science Learning

Purpose

- Enrich understanding of contexts
- Approachable form of teaching
- Plain fun!
- Enhance creativity, autonomy

Hands-on science learning has so much to offer that I'm continuing on another slide!

It's important to offer teaching practices that mesh with how students learn best.

Hands-on Science Learning

“The result of many interpersonal exchanges, of interactions with materials... which can be further discovered through collaboration.”

Karen Gallas, *Talking Their Way Into Science: Hearing Children’s Questions and Theories, Responding with Curricula*

Science learning should be introduced to children through open-ended play with materials.

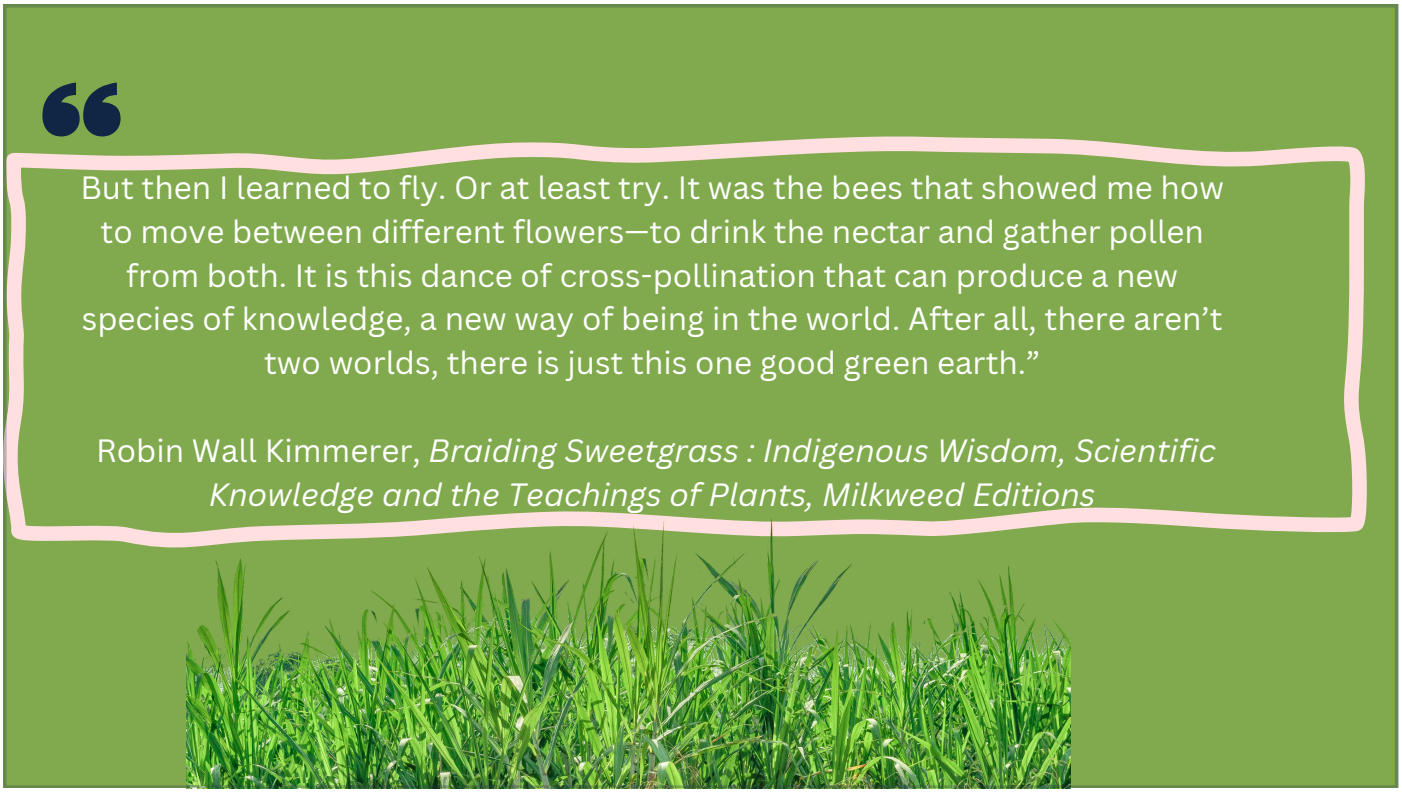
Gallas does a great job stating the relationship that exists between children and science when they are able to have the opportunity to interact with this type of science learning.

The Relationship Between Hands-on Science and Nature

Braiding Sweetgrass-Indigenous Roots of Connecting with Nature

All information and practices we know and use today come from indigenous practices. It is essential that we first look at indigenous practices for caring for nature, and speak of how these practices allow us to continue caring for species.
Robin Kimmerer shares her story of being an indigenous scientist, and the hardships and identity grappling she faced with being told by professors that her approach "wasn't science". That science was mechanized and impersonal.

-Asters and Goldenrod
-grow together and attract pollinators to continue to help the planet



Kimmerer held onto her beliefs and the justice that plants, animals, and beings deserve.

I've read excerpts of this book for different courses, and have listened to Kimmerer speak about this book.
When I spotted this quote, I almost began to cry from the absolute beauty and deep connections that we have with nature. I'm going to read it a bit slower than I normally would because of the rich language.

I find this incredibly moving and, shows the depth and courage that nature beholds and happens around us. And it is up to us to step back and look around to see these process happen.

Childrens' Connection to Nature

> "Roger Hart (1979) found that children spent long stretches of time simply watching wildlife. And their careful observations led to expert knowledge."
>
> Cited by William Crain, "Nurturing the Remarkable Powers of Children"

Children have a natural love for nature, and there are many opportunities for children to use this knowledge in school

Childrens Connection to Nature Continued

"Play in nature can improve motor skills, increase cognitive functioning and attention capacities."

(Kuo et al, 2000), cited by Victoria Derr, Krista Lance

-Wonderforest Nature School found important for children to play and be outside and form connections with nature
-Children playing mud kitchen concentrated on their play, using fine motor skills, and collaborating
-Community, autonomy, and play are all key parts of the benefits of hands-on science learning and are all happening

The Early Childhood Center fosters the ability for children to be able to explore their curiosities through play. :)

Children have the time and space to get messy through playing, running, rolling outside and through conducting experiments, and manipulating materials inside.

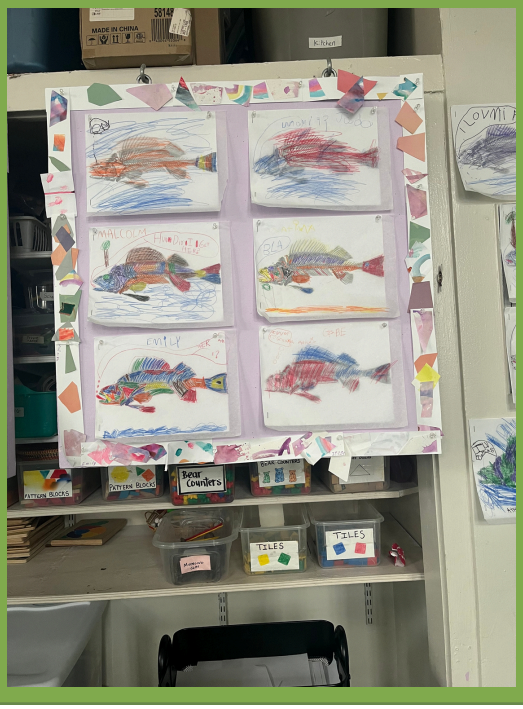
This is a comulation of the children making my "snack" by working together to forage for loose parts in the yard such as spare chalk, mud from the mud kitchen, spare leaves, sticks and a watercan for added nutrients. This "snack" took many forms throughout the year, and brought children together through brainstorming what to put in my "snack"!

The ECC collaborated with CURB (Center for the Urban River at Beczak)

The children learned about worm composting (Vermicompost) and got to play with the worms from the compost. A lot of them at first wanted nothing to do with the worms, but Lilu's eyes lite up when she saw the worms and she was the first child to bravely pick up a worm. Here, it's resting on her shoulders. She became elated and said "aww this is a cute one"! Then other children began feeling more comfortable picking up the worms and interacting with them.

This section will be examples from my student-teaching placements that show how hands-on science learning can emerge!

Childrens' Presence in the Classroom



I got the pleasure of student teaching with Jenn and Kori at Brooklyn New School in a Kindergarten ICT classroom.
Jenn and Kori's classroom is set up so children can have direct access to the materials that they use daily. And has items that children should not touch, away from their reach (find quote about this)

Jenn and Kori work closely with Beth a child development and psychology professor at Brooklyn College, who introduced Play World into Brooklyn New School. Playworld consists of introducing a story to the class, and then re-creating the story through play. Jenn and Kori dress up as the two main characters Mona the Mouse and Tily the squirrel from Heartwood Hotel A True Home by Kallie George. This is Mona's tree, it is an ever-changing space where PlayWorld continues to happen in the classroom.

This is Swimmy! She is around 20 years old and a special part of the class.

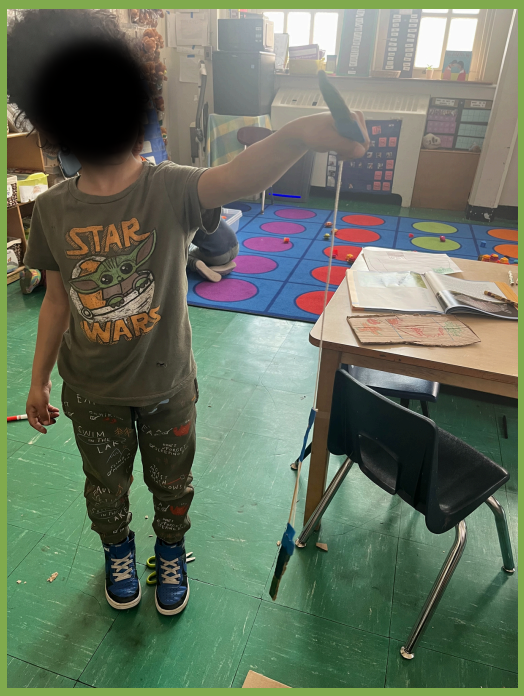
Right below Swimmy are materials that further allow children to explore Swimmy and science in the classroom such as magnifying glasses and step stools to stand on and get a closer look at Swimmy!

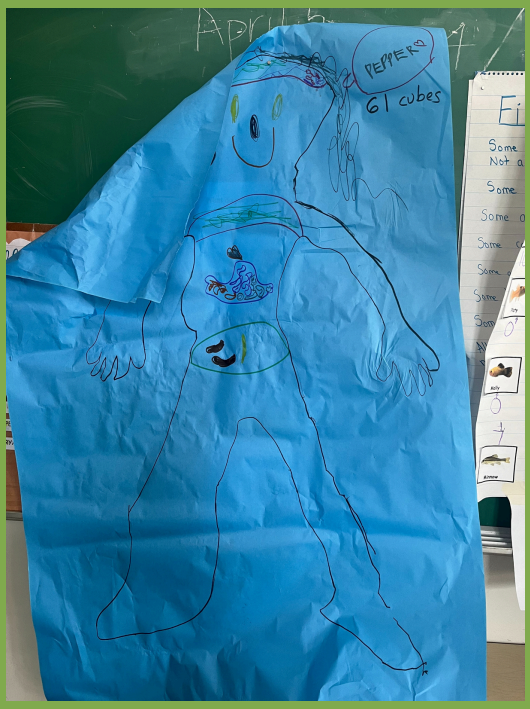
The kindergarten curriculum is called Shore School. All kindergarten classes go on frequent trips to the Marine Park Salt Marsh in Brooklyn, New York, where children can just play, explore and dig in the sand and use buckets of water and draw.

Part of the Shore Curriculum is having children build with clay once a week in the classroom. They were asked to think about what they do at the Shore and recreate it with clay. So there's a child sitting on top of the drawing rock, the gutter with water that has been poured into it.

This deep understanding and passion for the salt marsh was heard from children first getting excited to recreate it, and brainstorming what the saltmarsh means to them.

Science Occuring Naturally in the Classroom



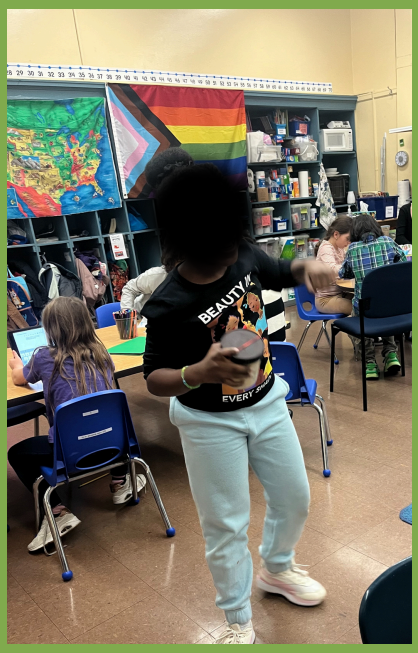


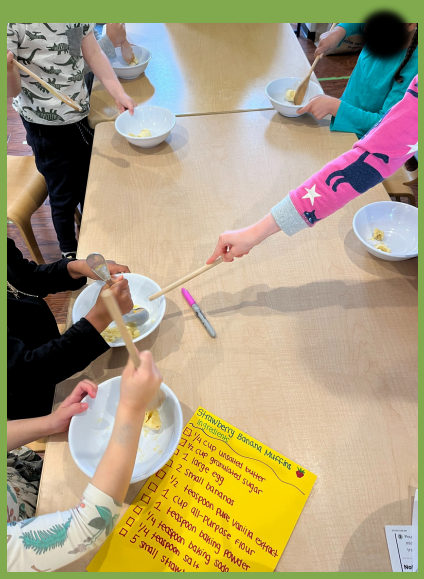
During worktime at the art table Ajani called out "look I'm going fishing". He made his fishing poll out of cardboard and rope. You can't see it in this photo but he made a tiny fish out of cardboard that was attached to the bottom of his pole.

Children worked in pairs and traced eachother's bodies, then used unifx cubes to see how many cubes tall they are. Then they color draw their face and add any other details. Pepper's details centered on what happens inside of her body. When asked about what the brown and yellow details are she replied "the yellow is pee and the brown is poop". She is taking the knowledge she has of how the body works and applying her understanding of the complex system.

These two moments show that there are many opportunities to teach further into topics that children are interested in, and the importance of taking moments out of our day to engage in children's interests and further their understandings. (find quote)

Cooking

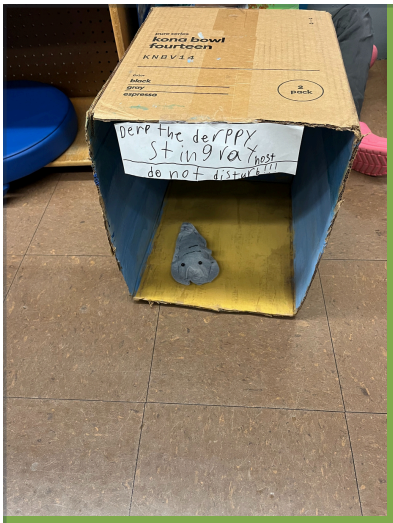




Cooking was a way that I could incorporate hands-on science learning in my classrooms. Cooking can require measuring, mixing, chopping, shaking, and transforming ingredients into a new form!

During cooking children are able to be in control of completing a specific task such as mashing a banana for banana muffins and they see live how the different nutritional properties blend together to create the final product of the recipe.

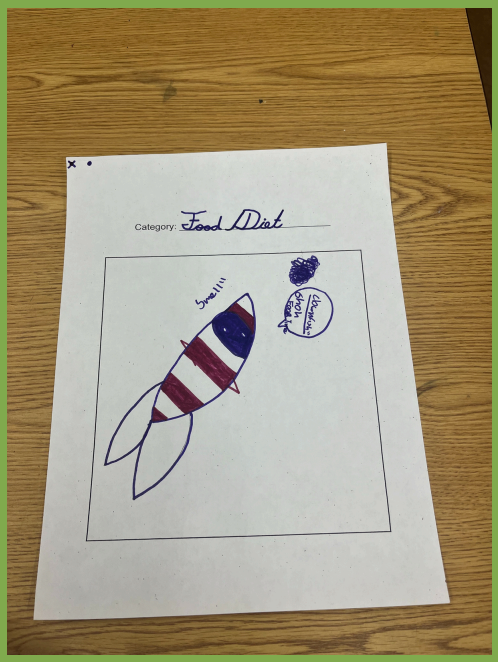
I was able to help with cooking in Evangelyn's class basically once a week, and I did cooking with Liz and Christine's 3rd grade class once a week! In both settings with children different ages, there is a joy, excitement and creativity that children bring to cooking in the classroom!

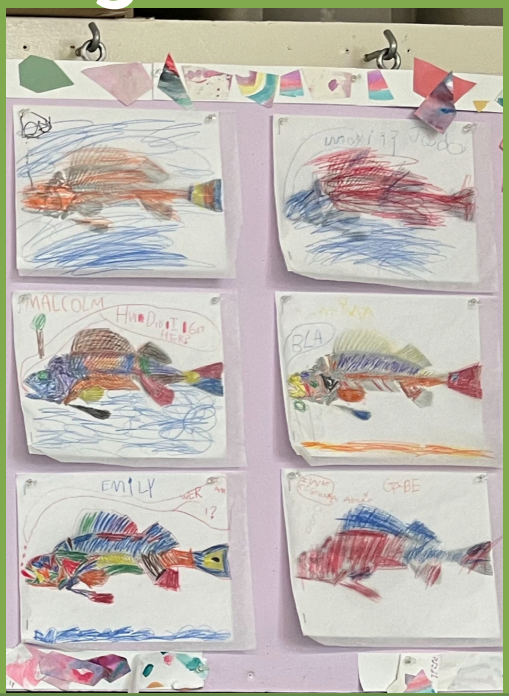


The levels of creativity that children bring to project-based learning. The students chose which form they wanted their project to be: sewing their animal/sewing an animal customer, painting, or writing a skit.

A project that Violet made in Liz and Christine's for the ocean creature unit. She researched a stingray, Derp. She sewed the stingray stuffed it, and made a habitat equipt with a comfortable floor padding.

Animals' Voices Coming to Life





This first picture is a page in a child's ocean creature project book. Where students researched an ocean creature in categories such as food diet, habitat and drew pictures to go with it.

The second, children used tracing paper and traced an image of a fish skeleton, then added a thought bubble or speech bubble and wrote what their fish was thinking.

This shows the inherent connection that children have to nature, which will be explored more in-depth later on in this presentation.

> Most children are willing to work hard-eager to work hard-so long as they're excited about the things they're working on."
>
> Mitchel Resnick, *Lifelong Kindergarten: Cultivating Creativity through Projects, Passion, Peers, and Play*

This shows the importance of creating intentional curriculums. Intentional meaning they are based on observations of students' understanding and interests in science.

Resnick highlights how through integrating science talks students will get opportunities to connect with peers through answering guided questions that are brought up by the class based on the current science curriculum.

Galls further mentions the importance of letting the conversation consist of student voices and the importance of the teacher being a listener and observer (Gallas, 1995).

Evangelyn knew that a lot of our kids loved using their hands and getting messy in their play, and we struggled sometimes on how to "best" engage students. So she thought of a brilliant idea of filling ice-cube trays with baking soda in half and water in the other. The kids had water with different color food coloring and they used a pipette to squeeze bits of water into the different cubes. Their excitement floursihed when they saw the reaction that occurs when you mix baking soda with a bit of water, an "explosion"!

The children experimented with using a pipette to squeeze bits of water on baking soda to see what'll happen.

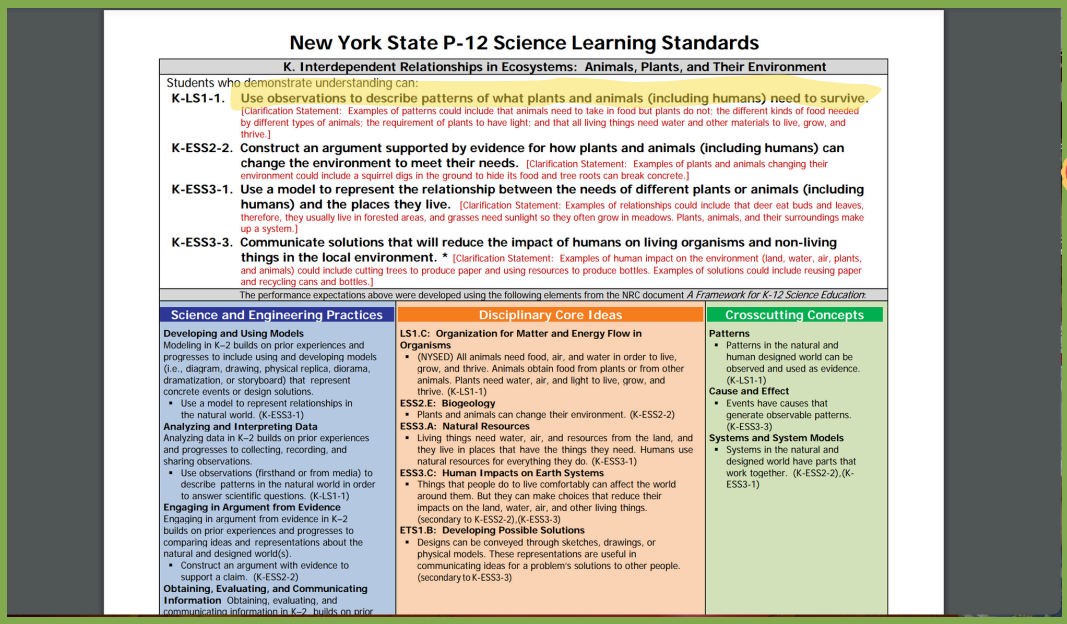
We made ooblek combining cornstratch and water. We let the children mix up the ingredients and see what happens. This became a recipe we would make often, and children who typically only played an activity for a brief amount of time could stay at the "messy table area" for almost the whole free choice time!

Hands-on science learning should be a known time where children are able to pull into their curiosities, question everything and find out these answers through exploration.

Through researching and creating this thesis, I thought about focusing more on the lack of hands-on science opportunities in school. But then I thought about my student-teaching experiences, about how hands-on science is engaging and an entry point for all learners, and is not based on ability but on one's observations, experiences, and curiosities. This type of learning holds such deep importance for creating maybe the only part of a school day where children are being exposed to these practices, and have time to explore. This is what I keep holding onto. I choose hands-on science learning for this presentation for a mass of reasons, stemming from my personal deep and complicated love of the subject, and for its connections to children's learning and relationship to nature. However, this practice of hands-on learning is impactful in more school areas than just science. You can think of a traditional school curriculum, and implement hands-on learning instead of just completing worksheets.

Creating opportunities for hands-on science learning to happen
Afterschool program

New York State P-12 Science Learning Standards



New York State P-12 Science Learning Standards

K. Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment

Students who demonstrate understanding can:

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and that all living things need water and other materials to live, grow, and thrive.]

K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]

K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. [Clarification Statement: Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas, and grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.]

K-ESS3-3. Communicate solutions that will reduce the impact of humans on living organisms and non-living things in the local environment. * [Clarification Statement: Examples of human impact on the environment (land, water, air, plants, and animals) could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.
- Use a model to represent relationships in the natural world. (K-ESS3-1)

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1)

Engaging in Argument from Evidence
Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).
- Construct an argument with evidence to support a claim. (K-ESS2-2)

Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in K–2 builds on prior

Disciplinary Core Ideas

LS1.C: Organization for Matter and Energy Flow in Organisms
- (NYSED) All animals need food, air, and water in order to live, grow, and thrive. Animals obtain food from plants or from other animals. Plants need water, air, and light to live, grow, and thrive. (K-LS1-1)

ESS2.E: Biogeology
- Plants and animals can change their environment. (K-ESS2-2)

ESS3.A: Natural Resources
- Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. (K-ESS3-1)

ESS3.C: Human Impacts on Earth Systems
- Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (secondary to K-ESS2-2),(K-ESS3-3)

ETS1.B: Developing Possible Solutions
- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to K-ESS3-3)

Crosscutting Concepts

Patterns
- Patterns in the natural and human designed world can be observed and used as evidence. (K-LS1-1)

Cause and Effect
- Events have causes that generate observable patterns. (K-ESS3-3)

Systems and System Models
- Systems in the natural and designed world have parts that work together. (K-ESS2-2),(K-ESS3-1)

This is a standard pulled from the New york State 9-12 Science Learning Standards for Kindergarten.
K-LS1-1. Use observations to describe patterns of what animals (including humans) need to survive).
This is quite vague and that's great. Hands-on science can for sure be implemented!
-other nys learning standards in other subjects that relate to this standard=shows the interdisciplinary nature of these standards

New York State Next Generation Learning Standards Connections:
ELA/Literacy –
KR1 Develop and answer questions about a text. (K-ESS2-2)

KW1 Use a combination of drawing, dictating, oral expression and/or emergent writing to state an opinion pieces about a familiar topic, personal experience
and state a reason to support that topic.

Literacy-
KW2. Use a combination of drawing, dictating, oral expression, and/or emergent writing to name a familiar topic and supply information.

Mathematics –
NY-K.MD.2 Directly compare two objects with a common measurable attribute and describe the difference. (K-LS1-1)

Future Scientists

“I’m a scientist for real, I go on adventures.”

Jack, 5 years old, Brooklyn New School

This idea of children deciding what they are, before society puts pressure on them.
A natural way of thinking. I explore, therefore I am a scientist. This all flows with the need to be present in nature.

> Children interested in butterflies may, for example, be first attracted by their colors or their movements (essentially their aesthetic qualities); later;-by questions posed, by the interests of others, by closer observation, they become interested in their life cycles, periods of dormancy, and activity. Such interests could go in many directions, even beyond butterflies."
>
> Vito Perrone, "How to Engage Students in Learning."

Thanks so much for listening! Let’s continue keeping exploration, creativity and, joy alive in teaching :)

Leo standing proud in his rain gear and he made a dam with mud and sand that collected water from the shore to protect his friend's structure.