Observing and Identifying Scientific and Engineering Practices in Play

Recap from last week

Observations

- By observing rather than asking questions we don't interrupt the child's work and therefor we can collect useful data.
- Using what we hear and see rather than what we think about what we hear and see builds strong objective note taking,
- Collecting observations in writing in order to use them strategically in curriculum planning.

Curriculum

- Is planned based on careful objective observations,
- Discussed using notes and a team approach,
- Builds on children's interests rather than a prescribed curriculum.
- Is cyclical; staying with and revisiting practices and interests of the child over time

Why are science and engineering practices so important?

The *Framework* asserts that science is more than a body of knowledge about the world, but that it is also "a set of practices used to establish, extend, and refine that knowledge" (NRC, 2012, p. 26).

As students model how scientists work, they develop a better understanding of the process of scientific inquiry (Bybee & Van Scotter, 2007).

It is through engagement with practices that *scientists* develop new understanding, so it can be inferred that science practices are also important to advancing *student's* understanding of science.

Why “do” science in early childhood?

“When curiosity is the freshest, and the perceptions keenest, and memory most impressible, before the maturity of the reflective powers, the opening mind should be led to the art of noticing the aspects, properties and simple relations of the surrounding objects of Nature”

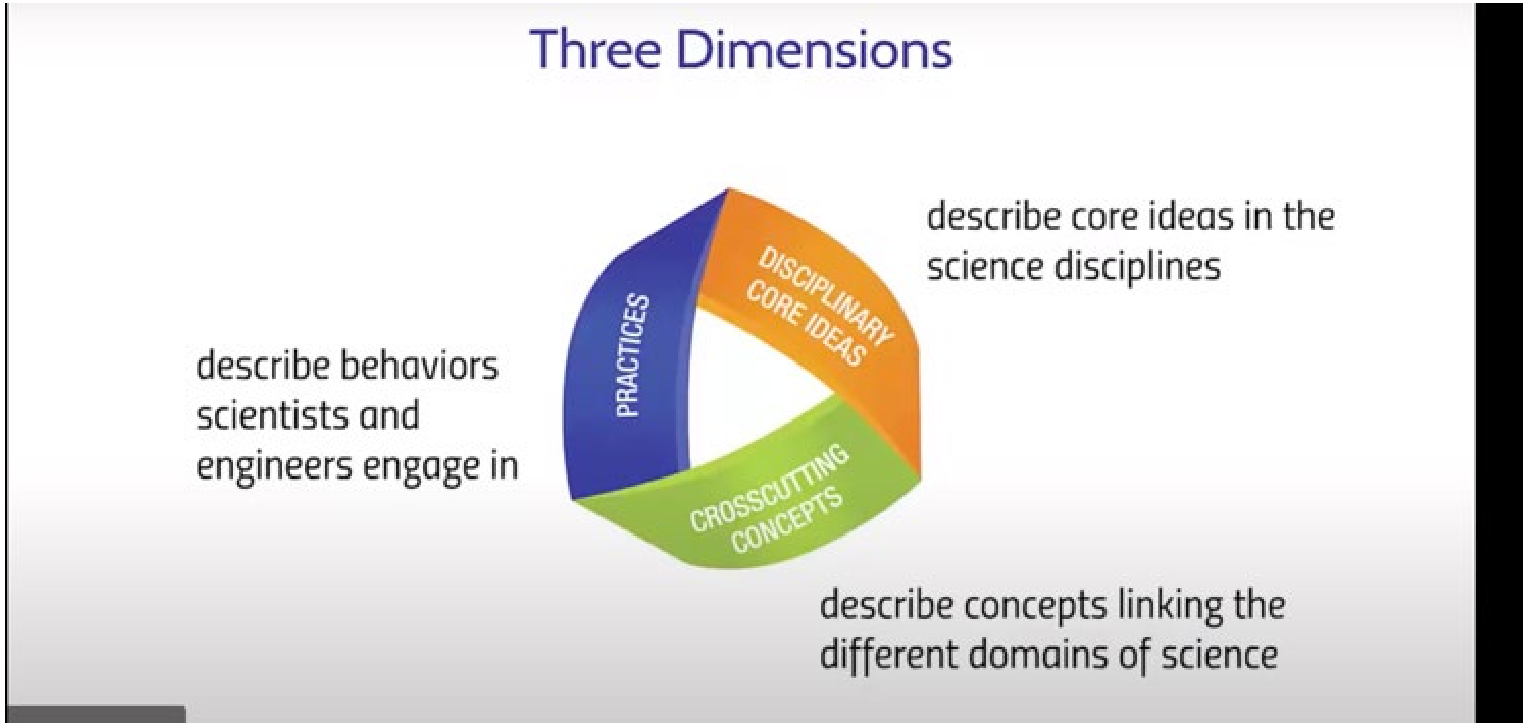
E.L.Youmans, Educational Theorist (1867)

They are already engaging in scientific inquiry

We need to:

- Facilitate opportunities
- Articulate what we are seeing
- Build our own awareness

Next Generation Science Standards (NGSS)
A Framework for K-12 Science Education



Disciplinary Core Ideas in Science Education

The Disciplinary Core Ideas (DCI) are grouped into four categories:

- Physical Science
- Life Science
- Earth & Space Science
- Engineering

Each DCI outlined in these four domains build on each other as children progress through grades.

- There are 41 DCI in total

How do children learn best?

- In the early years you want to expand opportunities for learning, build experiences, create invitations, and observe to see and hear what they are doing.
- During these early years, children experience their world and develop skills through their play and movement. The freedom to find themselves in play that they create is powerful and fundamental to learning.
- DCI is referred to as NGSS curriculum. It offers specific curriculum goals and objectives to be taught, assessed, and completed. We wait to offer specific curriculum until they are school-aged.

Preschool curriculum works backwards from what was observed to what is offered…

- Thread back from what you see to what you know about these principles and understand that what you are seeing is STEM

- Create curriculum, extend their investigations, develop invitations for further explorations based on your observations.

Seven Cross Cutting Concepts in Science Education

- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter
- Structure and Function
- Stability and Change

Patterns

Patterns are in nature, seasons, regularly occurring shapes, repeating events, with sticks, blocks, and rocks.

Cause and Effect

Events have causes sometimes they are simple and sometimes they are complex. Deciphering causal relationships, and how they happen, is a major activity of science and engineering.

Children can use their experiences in social relationships to learn about causal relationships as well.

Systems and System Models

A system is an organized group of related objects or components so models can be used for understanding and predicting the behavior of systems.

Blocks, ramps, maps, roads, building outside and inside, and gardening are activities where you might see this.

Structure and Function

The way an object is shaped or structured determines many of its properties and functions. Children embody much of this knowledge from birth as they discover their own body's structure and function.

How they understand themselves is seen in their running around as they when they arrive to the play yard…

We also see this through movement, dancing, jumping, and climbing

Children's engagement with different materials gives them the flexibility to be imaginative and creative. Loose parts offers this opportunity well.

Stability and Change

For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Using the children's conversation about weather: summer is hot, spring is muddy, winter is cold, fall brings falling leaves, we see how the weather changes and brings awareness of their world.

Eight Scientific Practices in Science Education

- Asking Questions & Defining Problems
- Developing & Using Models
- Planning and Carrying Out Investigations
- Using Math and Computational Thinking
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating and Communicating Information

Asking questions (for science) and defining problems (for engineering)

- Children ask questions in order to explain the world around them.
- By asking questions they can create successful solutions or clarify ideas.

Developing and using models

- Children use models to represent ideas and explanations. While they may not be able to describe how a bridge, they build across the water will hold them, they can build a model.
- That model is used to build explanations from and then they use their measurements and observations to revise those models.

Planning and carrying out investigations

Children plan investigations with materials that are at hand, that have been intentionally offered, and that have the durability of their design.

Using mathematics and computational thinking

- Children use counting and numbers to identify and describe patterns in the natural and designed world (2 of these here and 2 of these there).
- They may describe, measure, and compare quantitative attributes of different objects. (This bucket is bigger than the cup so it might hold more.)
- Children may compare two alternative solutions to a problem. (We could do this or this to build a structure.)

Analyzing and interpreting data

- Children analyze data to derive meaning. They look at what they have in front of them and then determine what that means to them.
- Patterns and trends are not always obvious to us or them, but they work to use the data and test designs
- They will compare their predictions to what occurred. “I didn’t know that!”

Constructing explanations (for science) and designing solutions (for engineering)

- Children provide explanations for why they are doing something and find solutions using tools and materials to build a device that solves specific problems or solutions to a problem.
- Children might explain why the worms are out, a leaf if yellow, the clouds are moving based on their understanding of the world.
- When you hear children “building a machine to clean up, fight fire, catch the bad guys” they are working to design a solution.

Engaging in argument from evidence

- Reasoning and argument based on evidence is what you can hear as children work to explain a natural phenomenon or the best solution to a design problem.
- Often, if we listen carefully, we can identify their arguments that are supported by evidence.

Obtaining, evaluating, and communicating information

- Children communicate to each other and share information using oral communication, models, drawings, writing, or numerals.
- They provide detail about scientific ideas, practices, or design ideas in their play and the work they offer each other.

What does STEM mean to three-five-year-olds?

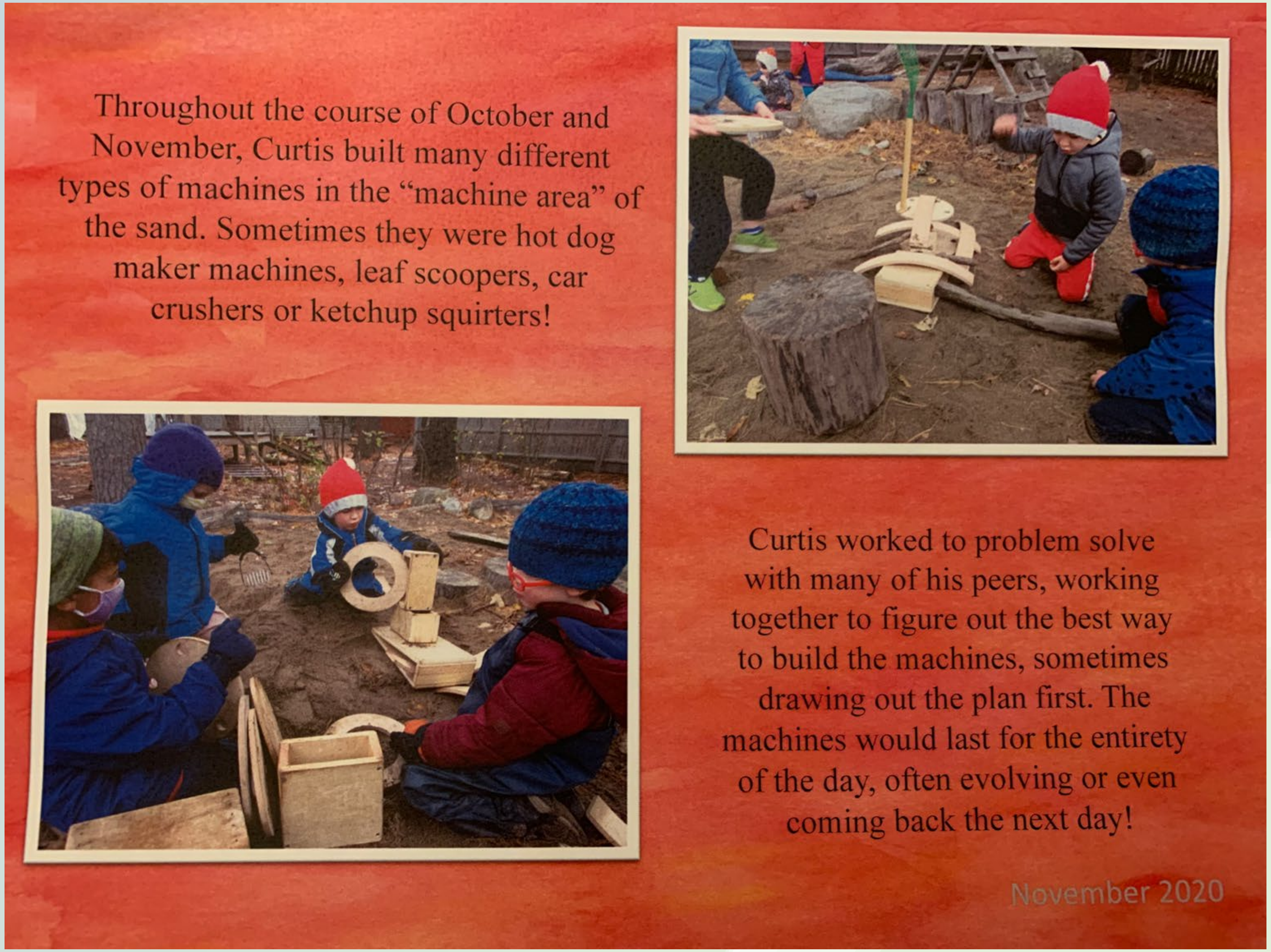
- Curriculum is discovery-based and emphasizes what we know about their natural and innate curiosity to discover the world.
- Play-based curriculum supports inquiry about the natural world through:
- Science: observation, experimenting, predicting, and questioning,
- Technology: using tools and making things work
- Engineering: building, creating, and problem solving,
- Math: sequencing; and identifying patterns, shapes, volume, and size

Authentic Assessments: Documentation

- Focus is on how and what children learn
- Typically tracks the process of learning over time (weeks, months, year)
- The very nature of assessing learning over time like this will highlight STEM practices
- May include children’s work, transcripts of conversations, photographs of engagement, teacher’s observations, etc.
- Documentation can be a tool to deepen learning in the classroom when made visible; should focus on one area, topic or project at a time.
- Makes learning visible to parents and public

Authentic Assessments: Child Portfolios

- Will highlight the learning processes for each specific child; many of which will include STEM practices and concepts.
- Materials such as anecdotes, photographs, work artifacts and quotes will come directly from observations, curriculum planning conversations and group learning documentation.
- Will assess and demonstrate how children are learning and developing over time. Portfolios should travel with children through a program.
- May not coincide specifically with standards but growth and development is evident.



Authentic Assessments: Child Narrative Reports

- A Child Narrative incorporates both standards and documented child learning into one document.
- All the data collected on a child through observation, curriculum planning, documentation and portfolios is written out to highlight the progress towards formal standards of learning.
- A child narrative focuses on growth and development towards specific goals, not where the child is deficient.
- While learning domains may be separated out in a child narrative, the whole child view is always taken.

Sample Narrative Template

One way to assess children's learning

Bowdoin College Children's Center

First-Year Preschool Fall Conference Form

Child: **Date of Birth**: **Group**: First Year Preschool

Teachers: **Date:**

Social and Emotional Development:

The first preschool year is a time when children experience a great transition from a smaller group or another environment to this larger group and program. Our initial goal is to secure the child in a predictable and consistent relationship, so we assign co-lead educators small groups of six or seven children. These special bonds help children anchor themselves to a known person throughout their day, anticipate a trusting relationship, and find freedom to understand the routines, engage in deep meaningful play, and start to build relationships with peers.

During the routines: eating, toileting, dressing, and napping, co-leads guide their primary children through each of them to offer reassurance. Through these moments, children feel proximity which provides security, a recognition of similarity with their educator, and a sense of belonging to the group. As these connections take hold, the relationships with their primary educator anchor them in their day and offer them a role model to guide them. Educators model behaviors (doing tasks, chores, and working) or use language (making requests, offering reassurances, and engaging in conversation) to support them through the day and deliver them to full participation inside of these nurturing relationship.

Physical Development:

The preschool curriculum provides many experiences and activities that help strengthen children's physical development. A child entering preschool immediately meets many challenges in the environment: a play yard that is big and invites running, jumping, balancing, climbing, pushing, pulling, shoveling, and raking. Children watch their older peers navigate more advanced tools such as large shovels and wheelbarrows as well as take more risks such as climbing trees, moving ramps and platforms, building structures, or balancing on high stumps. A younger preschooler has ample opportunity to practice these skills as they observe others and sometimes meet with frustration while working toward a goal.

Indoors, children care for their environment and participate in more intricate activities to build small muscles (hand, finger, and grasps). Filling water bottles, folding laundry and self-care tasks such as eating, and dressing provide constant opportunities for children to engage their physical body. Activities such as cooking, painting, gluing, cutting, and textile-work are introduced this year so that children use eye hand coordination and motor planning to complete their goals during these activities.

Cognitive Development:

Cognitive skills developed during the first preschool year prepare children for the tasks they will encounter as they move into their second preschool year and beyond. The first step in creating a landscape for learning is for children to have a strong emotional connection with adults in their world. Our work to build strong relationships is foundational when we consider cognition. Development in this area helps foster more advanced abilities in problem solving strategies, classification, perseverance, and a greater understanding of their world. The first cognitive challenge a child experiences is to understand the daily routine and rhythm of this new program. The consistency of our daily schedule and program routine provide comfort as preschoolers work individually to master tasks, which require perseverance. Being able to understand, sequence, and predict the daily routine is a cognitive experience for these children. The predictable schedule, extended time for play, and open-ended materials set the stage for appropriate learning opportunities.

Cognitive Development: (First Year Preschooler)

Cognitive skills developed during the first preschool year prepare children for the tasks they will encounter as they move into their second preschool year and beyond. The first step in creating a landscape for learning is for children to have a strong emotional connection with adults in their world. Our work to build strong relationships is foundational when we consider cognition. Development in this area helps foster more advanced abilities in problem solving strategies, classification, perseverance, and a greater understanding of their world. The first cognitive challenge a child experiences is to understand the daily routine and rhythm of this new program. The consistency of our daily schedule and program routine provide comfort as preschoolers work individually to master tasks, which require perseverance. Being able to understand, sequence, and predict the daily routine is a cognitive experience for these children. The predictable schedule, extended time for play, and open-ended materials set the stage for appropriate learning opportunities.

Children engage with materials for longer periods of time, work through periods of frustration, ask open-ended questions, and lean on their co-leads to model problem solving. Once a child feels secure in their understanding of the program, they are free to immerse themselves in this play.

Cognitive Development: (3rd year Preschooler/Kindergarten Ready)

Cognitive skills developed during the third preschool year solidify how children prepare for the tasks they will encounter as they move into their early grade school years. Development in this area helps foster more advanced abilities in problem solving strategies, classification, perseverance, and a greater understanding of the world. In the preschool program, the co-leads use an emergent curriculum model, which takes the interests and questions of the children and expands upon their curiosity. Hands-on experiences and open-ended questions provide opportunities to practice problem solving, reasoning skills and promote inquiry-based investigation. Activities such as block building and dramatic play are designed to encourage children to work together to find solutions to their problems. By the time children leave the program, they have reached many cognitive milestones, preparing them for and developing their math and science skill sets.

Children begin to think logically and have complex thinking. We see a sense of either/or, and "on the other hand" which allows them to consider that they can feel one way and another way simultaneously. We will hear that "I like my friend and they made me mad". Now we see that their problems are more difficult to solve because they can see multiple solutions and perspectives. These nascent perspective-taking skills are exciting for the five-year old and create tension in conversations with younger children because of the gap in cognitive skills.

The play-based science curriculum revolves around the eight core practices of science education specifically: asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using math and computational skills, constructing explanations and designing solutions, engaging in argument from evidence, obtaining, evaluating, and communicating information. Both when they are outdoors and indoors, our older preschoolers are exploring and learning these practices by actively engaging with the environment around them. Building with loose parts, engineering solutions to their problems, observing the seasonal changes of the environment, gardening and collecting data from their inquiries are examples of these concepts coming alive in their play. Math and science skills are practiced throughout the daily routine as well. Folding laundry, setting the table and sequencing moments of the day touch on important pre-math skills for our older children.

Implications for Practice

How do you know when learning is occurring for your children? What do you do with this knowledge?

Do your assessment practices authentically meet your programming philosophy?