Little Scientists: Considering New Approaches to Early Childhood Learning

**Children are scientific learners**

It is conventional wisdom among scholars and practitioners that pedagogy is the engine of learning among young children. This conclusion derives from the assumption that children below a certain age are irrational and “pre-causal” and therefore need guidance from adults to understand the workings of their world. However, recent scholarship suggests that young children learn effectively simply by interacting with and observing their surroundings. This scholarship illustrates the importance of independent reasoning in children’s learning processes and highlights the need for a critical examination of the prevailing models of early childhood instruction.

A bedrock assumption of popular scholarship on scientific thinking is that people create mental models that represent relationships between the things, ideas and contingencies they observe in their day-to-day lives. For instance, people create maps to depict the physical space between geographic locations, construct taxonomies to describe biological parity between organisms and design systems of structural rules that govern the composition of words and phrases. Each one of these models represents a hypothesis about some aspect of the world (For example, a map is an assertion that a particular region is defined by a certain set of topographic features). As such, they serve as cognitive shortcuts for making sense of our surroundings. Each of us constructs and uses models of this kind on a daily basis. Until recently, it was thought that the ability to engage in these processes was acquired sometime after the early childhood stage of development. Now, however, it is becoming clear that children of all ages have this ability.

A recent study by Xu and Garcia finds that children as young as eight months develop causal models of events from observations of statistical patterns. The study measured how long eight-month-old infants spent looking at experimenters who took a sample of mostly red ping pong balls from a box of mostly white balls, versus how long they spent looking at experimenters who took a sample of mostly red balls from a box of mostly red balls. The subjects took longer note of experimenters who pulled a mostly red sample from a mostly red box, leading Xu and Garcia to conclude that even at eight months old, a child’s expectations hinge on an experiential understanding of probability.
Going a step further, Kushnir et. al. concluded that when young children encounter surprising statistical patterns, they often adjust their expectations for how the world around them will operate. An experimenter presented individual children as young as twenty months with two boxes side-by-side: one containing mostly ducks with some frogs, and the other containing mostly frogs with some ducks. The experimenter then took a frog or a duck from one of the boxes and left the room. When the experimenter returned, the participating child was prompted to hand over the animal of his or her choice. When the experimenter had taken a frog from a majority frog box or a duck from a majority duck box, the child generally assumed the selection was random and therefore was equally likely to hand over a frog or a duck. However, when the experimenter had taken a frog from a majority duck box or a frog from a majority duck box, the child generally handed over the animal the experimenter had selected. This led Kushnir and his collaborators to conclude that 20-month olds are able to infer preferences from unexpected statistical observations and to use those preferences to generate new models for predicting behavior.

Scholarship also shows that young children can use statistical information to infer the existence of unobserved causes. Allison Gopnik found that when a blicket detector – a box that plays music when some item or combination of items are placed on top of it – only went off two out of six times in response to a particular pattern, young children concluded that some hidden cause had to be responsible for the four times the detector did not go off. Additionally, scholarship shows that children are capable of using statistical patterns related to their immediate surroundings to generate broader thought paradigms. Taking the blicket detector example, children observing that the detector only went off four times are likely to expand their conclusion that some unknown factor is responsible for the blicket’s failure into a broader organizing principle – e.g. sometimes things occur whose cause cannot be immediately observed.

Therefore, learning among children is advanced through play-based, experimental activities

What implications does this scholarship have for educational practice? Some say that it warrants curricular changes that will encourage experimental and experiential learning to a greater degree. Gopnik argues that learning environments that are too structured hamstring the natural ability of young children to engage in the sort of statistically-based information gathering encouraged by the studies outlined above. She suggests that this sort of information gathering best done through free social
interaction, as children learn best when they gather evidence directly from the world around them rather than from their teachers or parents. vi

One way to encourage and leverage free information gathering among young children is by encouraging them to engage in play-based learning activities. Kelly Fisher, et al. argue that play-based activities cultivate mathematical thinking skills that are vital for problem-solving. She argues that when a child engages in guided or free play that incorporates mathematical concepts, he or she learns not just how to perform basic arithmetic functions, but— even more importantly—how to apply those functions to the surrounding world: “In such contexts, children do not merely learn that “4” is a number between “3” and “5,” but that it represents a quantitative concept that they may symbolize in a variety of ways (e.g., four blocks to build a tower, four spaces on the game-board, four fingers). vii In other words, play-based learning activities help students use basic information about numbers to create broader thought paradigms. Fisher et al. encourage these activities to be undertaken by children independently in safe and controlled spaces, or as part of a classroom curriculum. However, whether the activities are “free” or “guided” by an instructor, scholars have found that children display a natural predilection for using manipulatives to perform numerical calculations while at play. vii

Robotics boosts play-based learning—so educators should consider integrating it into their curricula

While traditional manipulatives require no special training to use, using digital ones necessitates basic competency in coding. As the ticket to the world of advanced digital learning, numerous education scholars and futurists now consider computer coding an essential skill. During a recent technology program in Washington, D.C., one futurist recently called code “smart English,” and “the language that facilitates our lives,” viii and even advocated for making computer science education universal. viii Ongoing work in academia shows that learners at the early childhood level can use coding languages—despite their complex semantics and syntax—to bring their problem-solving skills to new heights through the use of robots. Studies show that play-based activities involving robots boost computational thinking and social awareness among young learners. Two leading American Universities in particular—Tufts University and Harvard University— are working successfully to demonstrate the value of play-based robotics activities for these learners.

At Tufts, a research group known as DevTech developed a social robotics program for young children known as TangibleK. The lifeblood of this program is a hybrid tangible/graphical computer language
called Creative Hybrid Environment for Robotic Programming (CHERP). CHERP brings the ability to code to students as early as kindergarten by eliminating the task of memorizing complex strings of numbers and letters and the rules that govern how they fit together. In the words of DevTech, “With CHERP there is no such thing as a syntax error.” CHERP allows children to create strings of behavioral commands for robots by arranging physical or digital blocks representing physical actions – e.g. forward, backward, spin – in sequence and using a computer program to convert the sequence into digital code. When children use physical blocks, a computer program generates a coding syntax from an image of the block sequences they create. Recent studies by DevTech show that children infer causation between their coding commands and their robots’ physical actions – e.g. “If I create ‘x’ sequence, my robot will do ‘x,y and z.’” “If I alter the sequence in ‘x’ way, it will cause my robot to change its behavior to ‘y.’” In other words, through the TangibleK program, children become little scientists – they develop and test hypotheses about their robots’ behavior and their ability to influence it. In addition to priming children for STEM learning at an early age, this also helps children grasp the concept that complex systems govern their own actions and the actions of those around them.

At the Massachusetts Institute of Technology’s Media Lab, scholars created a Social Robotics “SoRo” Toolkit. The toolkit teaches pre-school aged children how to create rules for a social robot using reusable vinyl stickers. Students can manipulate the stickers to create behavioral rules that an experimenter can command a robot to follow using a tablet-based app. Scholars at the Media Lab recently published an article describing an evaluation of the toolkit that included 22 pre-school students. They found that “85% of the children were able to create a valid rule by themselves, learning about triggers and actions.” Additionally, after working with the toolkit, 50% of the children became convinced of their capacity to use computational processes to alter a robot’s behavior: “10 of the 20 children (50%) changed their answer to the question: ‘Who can teach the robot new things?’ For example: one child answered initially: ‘You’ (i.e., the researcher), and after the interaction changed his response to: ‘Everybody! I can teach the robot new things.’ Another child initially answered: ‘A robot teacher,’ and after, answered ‘A teacher; I can teach the robot new things, and other kids too.’” Thus, in addition to teaching the children the rules of causation, the toolkit also emboldened them to think of themselves as scientists and engineers.

Given the evidence that play-based robotics activities boost confidence, social awareness and scientific learning among young students, educators should consider building these sorts of activities into their early childhood curricula. While Common Core standards and tightening budgets make experimentation
with play-based learning difficult in many schools, there may be an opportunity for institutions that promote non-traditional education – like libraries -- to ramp up this sort of experimentation.

Conclusion

Recent studies show that young children learn scientifically – constantly formulating and testing hypotheses about how their world functions based on the evidence surrounding them. This revelation underscores the value of play-based learning activities for early childhood students that encourage experimentation and social interaction. Recent innovations in coding and robotics have boosted the learning that can occur through these sorts of activities. Therefore, education institutions – including, and perhaps especially libraries – should look for ways to integrate play-based coding and robotics into their programs of instruction.

---


---


---


---
