Lifelong Kindergarten:
Cultivating Creativity through Projects, Passion, Peers, and Play

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Excerpt from Chapter 5: Play

Playpens and Playgrounds

People use the word *play* in many ways. They play games, they play sports. They play musical instruments, they play songs. They play the odds, they play the stock market. They play with toys, they play with ideas.

What do people learn as they engage in these different types of play? Some parents and educators are skeptical about the connection between play and learning, dismissing playful activities as *just play*. Researchers sometimes go to the opposite extreme. I once went to a conference called *Play = Learning*, implying that all types of play lead to valuable learning experiences.

In my mind, not all types of play are created equal. Some types of play lead to creative learning experiences; others don't. We need to ask: What types of play are most likely to help young people develop as creative thinkers? And how can we best encourage and support those types of play?

I like the metaphor suggested by Marina Bers, a professor of child development at Tufts University. Marina notes that there is a big difference between playpens and playgrounds: Both are designed to support play, but they support different types of play—and different types of learning.

A *playpen* is a restrictive environment. In actual playpens, children have limited room to move and limited opportunities to explore. Children play with toys in playpens, but the range of possibilities is limited. In her book *Designing Digital Experiences for Positive Youth Development*, Marina explains that she uses the playpen "as a metaphor that conveys lack of freedom to experiment, lack of autonomy for exploration, lack of creative opportunities, and lack of risks."

In contrast, a *playground* provides children with more room to move, explore, experiment, and collaborate. Watch children on a playground, and you'll inevitably see them making up their own activities and games. In the process, children develop as creative thinkers. As Marina describes it: "The playground promotes, while the playpen hinders, a sense of mastery, creativity, self-confidence, and open exploration." This is especially true of modern "adventure playgrounds," which are explicitly designed to engage children in building, creating, and experimenting.

One reason that I've always been attracted to LEGO bricks is that they are well-suited for playground-style play. Give children a bucket of LEGO bricks, and they can build almost anything they can imagine, from houses to castles, from dogs to dragons, from cars to

spaceships. Then, they can take apart their creations and make something new—in an endless flow of creative activity, just like children creating new games and activities on a playground.

But that's not the only way that children play with LEGO bricks. When some children play with LEGO bricks, they follow step-by-step building instructions to make the model that's featured on the front of the LEGO box. They build Hogwarts Castle from *Harry Potter*, or they build the Millennium Falcon from *Star Wars*. After they finish building, they put their finished model on display on a shelf in their room. These children are playing in the LEGO playpen, not the LEGO playground. They are learning how to follow instructions, but they aren't developing to their full potential as creative thinkers.

Of course, there is nothing wrong with providing children with some structure for their activities. Images of sample projects on the LEGO box offer one type of structure, providing inspiration and ideas for children as they get started. By following step-by-step LEGO building instructions, children can gain expertise with the materials, learning new techniques for building structures and mechanisms. Completing a complex model can be an enjoyable and satisfying experience, for all ages. But if the goal is creative thinking, then step-by-step instructions should be a stepping stone, not a final destination. For playground-style play, it's important for children to make the decisions about what to make and how to make it.

When we organize workshops for kids, we always try to support playground-style play. We provide various structures to help kids get started. For a LEGO robotics workshop, for example, we'll usually suggest a theme for the workshop, like "Underwater Adventure" or "Interactive Garden," to help spark ideas and encourage collaboration among workshop participants. We'll also show sample mechanisms that demonstrate different types of motion and provide a sense of what's possible. But we feel it's important for kids in the workshop to come up with their own ideas and plans. In an Interactive Garden workshop, for example, a child might imagine, then create, a robotic flower that closes its petals when something approaches. We want kids to experience the challenges and joys of turning their own ideas into projects. That's the essence of playground-style play.

In recent years, children have started spending more of their playtime on computer screens. This opens new opportunities for creative play and creative learning, but many of the new on-screen play activities feel more like playpens than playgrounds. Even the LEGO Group, with its long history of playground-style play in the physical world, has focused primarily on playpen-style activities on the screen. The company has produced an extensive collection of video games, many of them themed around movies and comic-book characters. The games definitely have a LEGO visual look: the objects and scenery are made of virtual LEGO bricks, and the characters are LEGO minifigures. But the style of play is very different from playing with a bucket of (physical) LEGO bricks. In the video games, kids learn to navigate through virtual worlds to score points and advance levels. But the games offer kids few opportunities to imagine new possibilities, set their own goals, or invent their own activities. In short, the games feel more like playpens than playgrounds.

It doesn't have to be that way. There can be playgrounds on the screen, just as in the physical world. The wild popularity and success of Minecraft is largely due to its playground-style approach. With Minecraft, kids can build their own (virtual) structures, craft their own tools,

invent their own games. There is a wide variety of different ways to play with Minecraft. Although Minecraft (virtual) blocks don't look like LEGO (physical) blocks, the play patterns are very similar.

Our Scratch software is another type of on-screen playground. Our original tagline for Scratch was "imagine, program, share." People often associate Scratch with programming, but imagining and sharing are just as important to the Scratch experience. Just as kids on a playground are constantly making up new games to play with one another, kids on the Scratch website are constantly imagining new types of projects and sharing their creations with one another.

Most other coding websites are designed as playpens, offering a constrained set of activities to help kids learn specific coding concepts. For us, the playground-style approach of Scratch is every bit as important as the computational ideas embedded in the programming blocks.

With so many different types of play—playing games, playing with toys, playing in playpens, playing on playgrounds—it's surprising that we have just a single word for play. But that's just a limitation of English. My colleague Amos Blanton, who worked on the Scratch Team at MIT before joining the LEGO Foundation in Denmark, was surprised to find that Danish has two different words for play. The word *spille* is used to describe the types of play that have a defined structure and sets of rules, like playing sports or playing a video game, whereas the word *lege* is used to describe play that is imaginative and open-ended, without an explicit goal. It seems appropriate that the Danish toy company is named LEGO (a contraction of *lege* with *godt*, meaning *play well*) and not SPILGO; LEGO bricks are explicitly designed to support imaginative, open-ended play.

Play is one of the four P's of creative learning. But to help children develop as creative thinkers, we need to distinguish between different types of play, putting more emphasis on lege than spille, and more emphasis on playgrounds than playpens.

Tinkering

When we were developing LEGO/Logo, the first LEGO robotics kit, we tested our initial prototypes in a fourth-grade class at an elementary school in Boston. One of the students, named Nicky, started by building a car out of LEGO bricks. After racing the car down a ramp several times, Nicky added a motor to the car and connected it to the computer. When he programmed the motor to turn on, the car moved forward a bit—but then the motor fell off the body of the car and began vibrating across the table on its own.

Rather than trying to repair the car, Nicky became intrigued with the vibration of the motor. He played and experimented with the vibrating motor, and began to wonder whether he might be able to use the vibrations to power a vehicle. Nicky mounted the motor on a platform atop four "legs" (LEGO axles). After some experimentation, Nicky realized that he needed some way to amplify the motor vibrations. To do that, he drew upon some personal experiences. Nicky enjoyed riding a skateboard, and he remembered that swinging his arms gave him an extra push on the skateboard. He figured that a swinging arm might accentuate the vibrations of the

motor as well, so he connected two LEGO axles with a hinged joint to create an arm and attached it to the motor. As the motor turned, the arm whipped around—and amplified the motor vibrations, just as Nicky had hoped.

In fact, the system vibrated so strongly that it frequently tipped over. A classmate suggested that Nicky create a more stable base by placing a LEGO tire horizontally at the bottom of each leg. Nicky made the revision, and his "vibrating walker" worked perfectly. Nicky was even able to steer the walker. When he programmed the motor to turn in one direction, the walker vibrated forward and to the right. When he programmed the motor to turn in the other direction, the walker vibrated forward and to the left.

I was impressed with Nicky's vibrating walker—but even more impressed by the strategies he used in creating it. As Nicky worked on his project, he was constantly *tinkering*. Throughout the process, he was playfully experimenting, trying out new ideas, reassessing his goals, making refinements, and imagining new possibilities. Like all good tinkerers, Nicky was:

• *Taking advantage of the unexpected.* When the motor fell off of his car, Nicky didn't see it as a sign of failure; he saw it as an opportunity for new explorations.

• *Drawing on personal experience.* When Nicky needed to amplify the vibrations of the motor, he relied on his experiences as a skateboarder and knowledge of his own body.

• *Using familiar materials in unfamiliar ways.* Most people don't imagine LEGO axles as arms or legs, nor do they imagine LEGO wheels as feet—but Nicky was able to look at objects in the world around him and see them in new ways.

Tinkering is not a new idea. From the time the earliest humans began making and using tools, tinkering has been a valuable strategy for making things. But in today's fast-changing world, tinkering is more important than ever. Tinkerers understand how to improvise, adapt, and iterate, so they're never hung up on old plans as new situations arise. Tinkering breeds creativity.

Tinkering is at the intersection of playing and making. In the same way that many people are dismissive of the value of play (*just play*), many are also dismissive of the value of tinkering (*just tinkering*). Schools tend to emphasize the value of planning over tinkering. Planning seems more organized, more direct, more efficient. Planners take a *top-down* approach: They analyze a situation, identify needs, develop a clear plan, then execute it. Do it once and do it right. What could be better than that?

The tinkering process is messier. Tinkerers take a *bottom-up* approach: They start small, try out simple ideas, react to what happens, make adjustments, and refine their plans. They often take a meandering, circuitous path to get to a solution. But what they lose in efficiency they gain in creativity and agility. When unexpected things happen and when new opportunities arise, tinkerers are better positioned to take advantage. As Media Lab director Joi Ito likes to say: "You don't get lucky if you plan everything."

Tinkerers constantly re-evaluate their goals (where they're going) and their plans (how to get there). Sometimes, tinkerers start without a goal. They spend time messing around with materials, playfully exploring what's possible, until a goal emerges from their explorations. Other

times, they start with a general goal (Nicky was planning to make a car), but are quick to adjust their goals and plans as new things happen (the motor fell off and vibrated across the table).

"When you tinker, you're not following a step-by-step set of directions that leads you to a tidy end result," write Karen Wilkinson and Mike Petrich, in their wonderful book *The Art of Tinkering*. "Instead, you're questioning your assumptions about the way something works, and you're investigating it on your own terms. You're giving yourself permission to fiddle with this and dabble with that. And chances are, you're also blowing your own mind."

Tinkerers believe in rapid prototyping and iteration. When working on a design project, they build something quickly, try it out, get reactions from other people, then make a new version— over and over. Tinkerers prefer to use screws, not nails. They're constantly making changes and revisions. When they're solving problems, they come up with a quick solution, something that sort-of works, then look for ways to improve it.

As we work on new projects in my research group, we're always tinkering—making new prototypes, testing them out, revising them, over and over. We developed dozens of prototypes of programmable bricks before the LEGO Group decided to move forward with LEGO Mindstorms as a product. Some prototypes proved to be dead ends; we backtracked and tried other options. Similarly, as we worked on Scratch, we constantly tried out new designs: How should the programming blocks fit together? How should the objects communicate with one another? We worked on one prototype after another—and we continue to tinker with the design of Scratch today.

Many of the greatest scientists and engineers throughout history—from Leonardo da Vinci to Alexander Graham Bell to Barbara McClintock to Richard Feynman—saw themselves as tinkerers. People often assume that all scientists are planners, because scientific papers make it seem as though every step was carefully planned in advance. But studies of scientists working in their labs reveal that scientists do a lot more tinkering than they describe in their papers.

Still, many educators remain skeptical about tinkering. There are several common critiques. Some educators worry that tinkerers might succeed at creating things without fully understanding what they're doing. That might be true in some cases. But even in those cases, tinkering provides an opportunity for learners to develop fragments of knowledge that they can later integrate into a more complete understanding.

Educators also worry that tinkering is too unstructured—that it doesn't provide the systematicity and rigor needed for success. This critique misunderstands the true nature of tinkering. The *bottom-up* process of tinkering starts with explorations that might seem rather random, but it doesn't end there. True tinkerers know how to turn their initial explorations (*bottom*) into a focused activity (*up*). Nicky spent a lot of time playing and experimenting with a vibrating motor (*bottom*) and then used his newly gained insights to create a walking machine powered by vibrations (*up*). It's a problem if learners get stuck only on the *bottom*; it's the combination of *bottom* and *up* that makes tinkering a valuable process.

People often associate tinkering with physical construction—building a castle with LEGO bricks, constructing a tree house with wood, creating a circuit with electronic components. The Maker Movement has reinforced this image, because it usually focuses on making things in the

physical world. But I see tinkering as an approach to making things, regardless of whether the things are physical or virtual. You can tinker when you're writing a story or programming an animation. The key issue is your style of interaction, not the media or materials that you use.

We explicitly designed our Scratch programming language to encourage tinkering. It's easy to snap together Scratch's graphical programming blocks and also easy to take them apart, just like LEGO bricks. To try out a stack of Scratch blocks, you just click on it, and it executes immediately—no waiting for code to compile. You can even make changes to the code as it's running. It's easy to quickly put together a little project, play with it, modify it, extend it—and you can enhance your project by pulling in images, photos, and sounds from the Internet, just as physical world tinkerers mix together materials from the world around them.

We need to provide children with more opportunities to tinker, with both physical and digital materials. The tinkering process can be messy and meandering, but that's true of all creative processes. A careful plan can lead to efficient results, but you can't plan your way to creativity. Creative thinking grows out of creative tinkering.

Many Paths, Many Styles

In the chapter on passion (the second of the 4 P's), I emphasized the importance of wide walls. In addition to providing children with easy ways to get started on projects (low floors) and ways for them to work on increasingly sophisticated projects over time (high ceilings), we also need to support many different pathways between the floor and the ceiling (wide walls). Why? Different children have different interests and passions, so they'll want to work on different types of projects. When children work with Scratch, for example, some want to create platform games, some want to create dance animations, some want to create interactive newsletters: Our wide walls strategy aims to support all of them.

There's another reason for wide walls. Children differ from one another not only in their interests and passions, but also in the ways they play and learn. If we want to help all children develop as creative thinkers, we need to support all types of play styles and learning styles.

The diversity of play and learning styles became obvious to us as we started testing our initial LEGO robotics kits in elementary-school classrooms. In one class, we asked the students what types of projects they wanted to work on, and they decided to create an amusement park, with different groups of students working on different rides for the park.

One group of three students immediately began working on a merry-go-round. They carefully drew up plans, then used LEGO bricks, beams, and gears to build the structure and mechanisms. After they finished building the merry-go-round, they wrote a computer program to make it spin around, then added a touch sensor to control it. Whenever anyone touched the sensor, the merry-go-round would spin in one direction, then the other. The group experimented with different computer programs, varying how long the merry-go-round rotated in each direction. The whole project, from initial idea to final implementation, took just a couple of hours.

Another group, also with three students, decided to build a Ferris wheel. But after working for 30 minutes on the basic structure for the Ferris wheel, they put it aside and started building a

refreshment stand next to the Ferris wheel. At first I was concerned. Part of the purpose of the activity was for students to learn about gearing mechanisms and computer programming. If they built only refreshment stands, without any gears or motors or sensors, they would miss out on important learning experiences. But I knew it was best not to intervene too quickly.

After finishing the refreshment stand, the students built a wall around the entire amusement park. Then, they created a parking lot, and added lots of miniature LEGO people walking into the park. They developed an elaborate story about several families coming from different parts of the city to spend a day at the amusement park. Only then, after the whole amusement-park scene was complete, did the students go back and finish building and programming their Ferris wheel. To them, building the Ferris wheel wasn't interesting until they had imagined a story around it.

In one study of how children interact with their toys, Dennie Wolf and Howard Gardner identified two primary styles of play. They described some children as *patterners* and others as *dramatists*. Patterners are fascinated by structures and patterns, and they typically enjoy playing with blocks and puzzles. Dramatists are more interested in stories and social interaction, and they often play with dolls and stuffed animals.

In the amusement park workshop, members of the first group would be classified as patterners. Their focus was on making the merry-go-round work, then experimenting with different patterns of behavior. Members of the second group would be classified as dramatists. They were interested in their Ferris wheel only when it was part of a story. The two groups were working with the same materials, learning similar things about gearing mechanisms and computer programming, but they had very different styles of playing and learning.

This variation in styles is not unique to elementary school students. It can be seen in learners of all ages, including university students. While we were developing the first programmable bricks in the early 1990s, two graduate students in our research group, Fred Martin and Randy Sargent, started a Robot Design Competition for MIT students. The competition has become an annual event. Every January, during the intersession between semesters, teams of MIT students spend four weeks—often working around the clock, with little sleep—to design, build, and program robots to compete against one another in specified tasks, such as gathering ping-pong balls or navigating mazes. At the end of the month, hundreds of spectators pack into the largest auditorium on campus to watch the finals of the competition.

Two faculty members at Wellesley College, Robbie Berg and Franklyn Turbak, were impressed with the MIT event, and decided to organize a similar activity for Wellesley students. But they felt that a robot competition wouldn't attract the same level of interest among students at Wellesley, an all-women liberal arts college. Instead, they organized a course called the *Robotic Design Studio*, with a somewhat different approach. Like the MIT Robot Design Competition, the Wellesley Robotic Design Studio is a month-long immersive experience, and participating students use similar robotics technology. But instead of creating robots for a competition, the Wellesley students have built a diverse collection of artistic and expressive creations, such as a robotic version of a scene from the Wizard of Oz. At the end of the month, instead of a competition, there is an exhibition of the students' robotic inventions—much like the opening of a new exhibition at an art gallery.

The Wellesley Robotic Design Studio has a different feel from the MIT Robot Design Competition. The Wellesley course seems more suited for dramatists; the MIT course seems more suited for patterners. But the results are similar. Both courses are extremely popular, and students in both courses learn important science and engineering concepts and skills.

Math and science courses, from elementary school through college, have traditionally been designed in ways that favor patterners over dramatists—just as they tend to favor planners over tinkerers. That's a big reason why many kids get turned off by math and science. Dramatists and tinkerers often get the message that math and science aren't for them. It doesn't have to be that way. The problem isn't in the disciplines themselves, but in how they're presented and taught. Sherry Turkle and Seymour Papert coined the term "epistemological pluralism" to highlight the importance of accepting, valuing, and supporting many different ways of knowing.

As my research group at the Media Lab develops new technologies and activities, we're constantly looking for ways to support many paths and many styles. For the amusement park workshop described earlier in this section, we provided students with not just gears, motors, and sensors (as would be typical in robotics workshops), but also miniature LEGO people and a wide range of craft materials (such as construction paper, pom-poms, and glitter). These additional materials were essential to creating the day-at-the-park story that motivated the dramatists on the Ferris wheel team.

It's also important to provide learners with sufficient time, because some paths and styles take longer than others. What if the amusement park workshop had ended after an hour? At that point, the first team (the patterners) had already completed a fully functioning merry-go-round, with a computer program to control its motions. The second team (the dramatists) had built only part of a Ferris wheel and a refreshment stand. If the workshop had ended then, the patterners probably would have been viewed as much more successful than the dramatists. Fortunately, there was additional time for the Ferris wheel team to continue developing its day-at-the-park story, then finish building and programming the Ferris wheel.

Learners differ from one another in many ways: Some are patterners, others are dramatists; some are planners, others are tinkerers; some prefer to express themselves through text, others through images. Many people wonder whether these differences result from nature or nurture— that is, whether styles are inborn or based on experience in the world. For me, that's not the most interesting or important issue. Rather, we should focus on figuring out ways to help all children, of all backgrounds and learning styles, reach their full potential. How can we develop technologies, activities, and courses that engage and support all different types of learners?

At the same time, we should push learners to reach outside their comfort zone. For certain types of problems, planning has advantages over tinkering; for other types of problems, tinkering has advantages. Exploring patterns is particularly helpful in some situations; telling stories is particularly helpful in other situations. Even if an individual learner is more comfortable with one style over another, it's useful to experiment with other styles and approaches. Ideally, all children should have the opportunity to engage with the world in a style that's most natural and comfortable for them—but also have experience with other styles, so that they can shift strategies as the situation warrants.