Learning from Mother Nature about Teaching Our Children

Ten Simple Truths About Childhood Education from an Evolutionary Perspective

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Education isn't working well in America, despite billions of dollars and everyone's best intentions. A recent workshop at the University of Miami explored new solutions from an unusual source: Darwin's theory of evolution.

Even from the long-term perspective of biological evolution, education isn't new. Beginning well over a million years ago, our ancestors began moving along an evolutionary track that made their survival ever more dependent on the transmission of culture from generation to generation. Culture is the set of learned skills, knowledge, attitudes and values shared by a group, and its transmission to each new generation is, by definition, education. We are genetically adapted for education, thus defined, but not necessarily for education as commonly understood in our schools today.

Against this background, the idea that Darwin's theory might inform modern educational practice isn't far-fetched. The workshop featured seven research specialists on childhood education and development who already appreciated an evolutionary perspective. It was organized by the Evolution Institute, a new think tank for informing public policy from an evolutionary perspective, and it was hosted by the University of Miami's Senior Vice Provost, William Scott Green, and Dean of the School of Education, Isaac Prilleltensky.[1]

During the workshop, it became abundantly clear that modern educational environments have departed sharply from ancestral learning and teaching environments. The evolutionary perspective does not automatically lead to a "back to nature" approach to education. The modern world is different from our hunter-gatherer past, so changes in educational practices would be expected. However, understanding our evolved abilities to acquire cultural skills and knowledge is essential if we wish to design maximally effective educational environments. To the degree that we can work *with* Mother Nature, rather than *against* her, we make education easier and more enjoyable for all. As a beginning, we offer here "ten simple truths" about childhood education from an evolutionary perspective.

Ten Simple Truths

1) Learning is child-motivated. The premier fact about education in hunter-gatherer societies and many other traditional societies is that its onus lies within children themselves. Adults do not deliberately train children, except in the sense of answering their questions and providing help that they seek. Adults treat children protectively but do not attempt to control their learning. They assume that young people will learn what they need to know through their own self-directed play and exploration, and therefore they allow children, even teenagers, ample free time for those activities.[2]

2) Children are biologically prepared to learn. The prolonged period of human childhood is, itself, an evolutionary adaptation[3] The drives and proclivities that characterize children everywhere are well designed, by natural selection, to help children survive during childhood and prepare for adulthood. Most relevant to education are children's extraordinary curiosity, playfulness, sociability, and capacity to practice intensely the skills that are valued in their immediate social environment. Children explore all aspects of the world around them, and they practice and play not just at the skills that are important to humans everywhere, but also at those that are unique to their particular cultures. Hunter-gatherer children practice and play at such skills as hunting, gathering, and hut construction, using the same tools and techniques that are used by older, skilled members of their groups. They spend countless hours at such activities until their play turns gradually into productive use of the skills. They tell and retell the stories that they hear from older members. They rehearse the rituals, dances, art forms, and other culture-specific activities that are valued by their group. They do all this with joy, on their own initiative. It would be difficult to stop them.[4]

3) The community is the classroom. Children in hunter-gatherer societies and other traditional societies are immersed in the activities of the whole community. They witness directly all the sustenance activities. They hear first-hand the stories, conversations, and arguments of adults, and they participate, along with adults, in their culture's dances, games, and ceremonies. Because they are exposed to all aspects of their culture, they can incorporate all of the culture's relevant skills into their practice and play. They attend not just to others' actions but also to the consequences of those actions, and their observations are tinged with value judgments.[5] Children learn what *not* to do from witnessing others' failures, just as they learn what *to* do from witnessing others' successes. They learn to emulate the most successful members of their culture—those who are best at solving life's problems and most admired by others—and to avoid acting like those who are least successful.

4) Learning must be immediately reinforcing. Education has unquestionable long-term benefits, but those are generally insufficient to motivate young learners. All species, including humans, find it difficult if not impossible to learn when the costs of learning are immediate and the benefits are much delayed. In the language of behaviorists, learning requires "reinforcers"—immediate, satisfying consequences that serve as incentives. In children's self-motivated exploration and play, the reinforcers lie in the discoveries made, the immediate sense of increased skill, the pleasures of the activities themselves, and social feedback (which may be as simple as a playmate's smile). These all contribute to the joy of learning. In today's world, such skills as reading and mathematics have long-term benefits, but children eagerly engage in them only if there are immediate benefits.

5) Learning occurs best in mixed-age settings. Before the existence of graded schools, children were rarely segregated from by age. Age mixing seems to be crucial for learning in hunter-gatherer and many other traditional societies. Children have more to learn from others who are older or younger than themselves than from those their same age. Young children want to emulate older children, who serve as more powerful models than adults because their skills and knowledge are closer and more attainable. In age-mixed play younger children engage in and learn from activities that would be too complex for them

to do alone or just with age-mates. In the process of helping younger children, older children consolidate their own skills. As every teacher knows, we often learn more by teaching than by being taught, especially if our students freely challenge us. Older children also exercise their nurturing and leadership skills through interactions with younger ones.[6]

6) An effective learning environment must accommodate individual differences. A species is not a uniform entity. Members of a single species often differ profoundly from one another and succeed in different ways. Some of the differences are largely genetically based, others are developmentally flexible early in life but then become relatively fixed, and still others remain flexible throughout life. These points apply to humans even more forcefully than to other species. For example, some children are more resilient than others in harsh environments, a difference that is partly genetically based. In Sweden they are referred to as "dandelion children." Others are less resilient, more like orchids. They suffer in harsh environments but may thrive even better than dandelion children in supportive environments.[7] Evolutionary analyses show how both types of individuals might be maintained in a population, based on different costs and benefits. As with resilience, so with other personality traits. Some children are bolder than others; some are more or less gregarious; some prefer action while others prefer reflection. Such differences are valuable not just to individuals but to the culture as a whole, which profits from the diversity of interests and abilities. When learning is child-motivated and offers sufficient choices, each person can find the educational niche that best fits his or her personality.

7) Learning is inhibited by fear and anxiety. When individuals of any species are placed in threatening situations, they direct their resources toward immediate self-protection. Open-ended exploration requires safety. To the extent that the educational environment elicits fear, it focuses learning narrowly on escaping or overcoming the fearful situation. Common sources of fear and anxiety in schools include bullying and teasing from other students, stereotypes that classify students as incapable, anxiety associated with testing and grading, and harsh criticism or threats of failure. At best, these forms of fear and anxiety focus learning on a narrow task, such as cramming for an exam. At worst, they paralyze learning altogether.[8]

8) Learning is facilitated by choice and inhibited by coercion. People of all ages, everywhere, cherish their personal freedom. They want to make their own choices and do not gladly submit to others' control. For example, adult workers greatly prefer jobs that give them autonomy to jobs that force them to follow the dictates of a micromanaging boss.[9] Throughout our evolutionary history, decisions forced by others have been far more often for the benefit of the controllers than those being controlled. One way that our ancestors became so different from other primates is that they found ways to resist domination within their groups, creating a form of guarded egalitarianism that favored cooperation and teamwork.[10] In a deep sense, we are a democratic species. Children are no different from adults in this regard; they resist being told what to do. This does not mean that they should be allowed to behave in unruly ways. Instead, it suggests that they should be allowed to participate in decision-making processes. Given the evidence that

participatory governance systems are beneficial in adult organizations, it is surprising how little educational research has tested the value of student participation.[11]

9) Departure from ancestral environments can create unanticipated problems. Species are adapted to their long-term past environments, not necessarily to their present environments. In new environments, old adaptations sometimes go spectacularly awry. As one example, the diet of many children today includes a much higher ratio of omega-6 to omega-3 fatty acids than the ancestral human diet, which may adversely affect neural and cognitive development. [12] Other examples include physical activity and touching. Schoolchildren are commonly required to sit still for extended periods, and touching is sometimes prohibited as a guard against sexual harassment. These practices have a surface logic in today's society, but they ignore the fact that physical movement and touching among trusted associates were always part of the human ancestral environment. Children who are deprived of movement and touching become hormonally stressed, which may compromise their ability to learn.[13] Many of the problems that schools and children experience today may be unintended consequences of educational environments that are strikingly different from ancestral conditions.

10) Some skills are acquired less spontaneously than others and require more deliberate effort. Some skills, such as walking and talking, have been essential for so many generations that we have become genetically prepared to learn them at an early age. Virtually all children practice those skills naturally in the course of their daily lives, more or less automatically. By contrast, other skills are unique to a given culture, and these may often require more conscious effort.[14] Every culture, including every hunter-gatherer culture, has such unique skills. For example, different hunter-gatherer cultures have different, often extraordinarily sophisticated ways of tracking game, depending on the terrain and the kinds of game they hunt. [15] They also have different sets of tools—such as blowpipes, bows and arrows, or snares for hunting—which must be crafted to perfection and require great skill to use. Reading and mathematics are examples of modern culturally valued skills that we are not specifically adapted, genetically, to acquire. Children will be naturally motivated to acquire such skills only to the degree that they observe them in successful role models or find such practice to be immediately useful and enjoyable. Even so, some amount of non-spontaneous practice and explicit instruction may be necessary for students to master these skills.

How Evolutionary Theory Can Improve Modern Education

These ten simple truths demonstrate the relevance of evolutionary theory for thinking about modern education. For people working within current, standard educational systems, these truths can promote an understanding of the stumbling blocks that lie in students' educational paths, and they may inspire ideas for removing or at least lowering some of those blocks. For people ready to try new models, the simple truths may provide a foundation for designing, from ground up, educational environments that capitalize maximally on children's natural ways of learning. Here are three very different ways that such ideas might be applied, ranging from the least to the greatest departure from current standard practices.

Teach in a manner that maximizes the immediate pleasure of learning and reduces fear. Much of the difficulty of modern education comes from the dreary sense that education is "work" that must be done now for future gain. The most effective teachers in modern educational institutions are generally those who teach in ways that lead students to enjoy the lessons in the short run. Contrary to what might initially be expected, the most effective methods toward that end are often straightforward, no-nonsense methods referred to collectively and generically as *explicit instruction*.[16] These techniques involve breaking complex tasks, such as mathematical operations, into segments that are taught sequentially, with the aim of mastery of each segment before moving to the next. Such step-by-step instruction capitalizes on children's natural enjoyment of seeing their own progress. It also reduces evaluation anxiety and fear of failure; the steps are small enough and clear enough that everyone can succeed. Much of the anxiety associated with current educational practices comes from students' uncertainty of what they are supposed to learn and how they will be evaluated. Explicit instruction reduces that uncertainty. Such instruction is clearly different from the most general means of learning among hunter-gatherers, yet it takes advantage of some of what we know about children's natural learning while reducing the fear associated with modern testing.

Improve the modern learning environment with evidence-based "kernels." Many current educational practices have superficial rationales but ignore unintended consequences. Examples include restricting movement and play (to make more time for instruction), no-touch rules (to avoid sexual harassment), age segregation (to facilitate formal instruction), autocratic rules (because adults know best), and using fear as an incentive (to maintain discipline and focus learning in a narrow sense). Appreciation of the unintended consequences may promote changes to practices that are more consistent with children's natural ways of learning. Opportunities for movement and play can be incorporated into the classroom, adequate recess time can be provided, touching can be allowed under appropriate circumstances, mixed-aged interactions can be facilitated, children can have greater roles in framing rules, and a safe, rewarding atmosphere can be cultivated. Some of the workshop participants are currently working with the Evolution Institute to create an inventory of evidence-based "kernels"—behavioral practices that have been scientifically validated and can be implemented in classrooms or other learning environments.[17]

Emulate the hunter-gatherer learning environment. In addition to the incremental changes provided by the kernel approach, our quest for more effective education should lead us to consider and evaluate radical departures from conventional modern learning environments. Is it possible for modern education to become as spontaneous, playful, and child-driven as learning in hunter-gatherer societies? This might seem to be too good to be true, yet some alternative schools have (without intending to) converged upon the hunter-gatherer model and appear to be remarkably successful. A set of schools worthy of special attention are the Sudbury schools, which now exist worldwide and are modeled after the Sudbury Valley School in Framingham, Massachusetts. In these schools, children and adolescents (from age four through high-school age) interact freely with one another while pursuing their own interests throughout the school day. All school rules are made by democratic procedures, with each student and staff member having an equal vote. There are no tests or imposed learning requirements, yet careful follow-up studies

show that the students thrive and the graduates become productive citizens.[18] Those who choose to pursue higher education (as most do), appear to have no special difficulties doing so. The per capita cost is a fraction of that for conventional public or private schooling. These schools are not restricted to high-achieving students; in fact, many students enroll because they were doing poorly in conventional public schools. Because of the self-selection in who enrolls, however, it is not known whether all children would benefit as greatly. Another question concerns whether the various practices are effective independently or must be combined into a whole package.

The ten simple truths apply to all kinds of education, formal and informal, in schools and out of schools. Although we have discussed their application to schooling, they are equally relevant for thoughts about neighborhoods, playgrounds, and youth activity centers—places where children can play, explore, and learn in age-mixed groups, with minimal adult supervision. Many parents and grandparents today quite appropriately regret the fact that their own children and grandchildren are less free to play, explore, and learn on their own initiative than they themselves were when they were young.[19] The tight control and supervision of children's and adolescents' activities that we see today is something entirely new to human history, and its unintended consequences may include the current high rates of childhood obesity, depression, and even suicide.

The ten truths exemplify, in one important realm, how evolutionary theory is profoundly relevant for understanding and improving the human condition. Although educational theorists may already appreciate many of these truths, or versions of them, they have not been effective in implementing them on a wide scale. An evolutionary perspective brings coherence to the truths and provides a framework for understanding them and for bringing them to bear in the design of educational environments.

Until now, there has been no mechanism for applying evolutionary theory to the formulation of public policy. The Evolution Institute is designed to provide this service. To learn more about education from an evolutionary perspective, including videos of the workshop presentations and access to the scientific literature, visit http://evolution.binghamton.edu/evos/MiamiWorkshop.html . To learn more about the Evolution Institute, visit http://evolution.binghamton.edu/evos/News_EvolutionInstitute.html.

Notes

[1] The first two authors of this article are co-founders of the Evolution Institute and organizers of the Workshop. They are **David Sloan Wilson**, SUNY Distinguished Professor, Departments of Biology and Anthropology, Binghamton University; and **Jerry Lieberman**, President, Humanists of Florida Association. The remaining seven authors are the researchers invited to the conference, in alphabetical order: **Daniel B. Berch**,

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[2] For documentation of hunter-gatherer beliefs about how children learn, and of the great amount of time hunter-gatherer children are afforded to play, see: Patricia Draper, "Social and Economic Constraints on Child Life among the !Kung," in R. B. Lee & I. DeVore (Eds.), *Kalahari Hunter-Gatherers* (1976); Yumi Gosso, Emma Otta, Maria de Lima, Salum Moralis, Fernando Ribeiro, & Vera Bussab, "Play in Hunter-Gatherer Societies," in A. D. Pellegrini & P. K. Smith (Eds.), *The Nature of Play: Great Apes and Humans* (2005); and Peter Gray, "Play as a Foundation for Hunter-Gatherer Social Existence," *American Journal of Play, 4* (2009), 476-522.

[3] David Bjorklund, "The Role of Immaturity in Human Development," *Psychological Bulletin, 122* (1997), 153-169; and David Bjorklund, *Why Youth is not Wasted on the Young: Immaturity in Human Development* (2007).

[4] For a general review of hunter-gatherer children's learning through play, see Gray, "Play as a Foundation for Hunter-Gatherer Social Existence." For evidence pertaining to specific cultures, see: John Bock & Sarah E. Johnson, "Subsistence Ecology and Play among the Okavango Delta Peoples of Botswana," *Human Nature, 15* (2004), 63-81; Nobutaka Kamei, "Play among Baka Children in Camaroon," in B. S. Hewlett & M. E. Lamb (Eds.), *Hunter-Gatherer Childhoods: Evolutionary, Developmental, and Cultural Perspectives* (2005); Lorna Marshall, *The !Kung of Nyae Nyea* (1976); and Colin Turnbull, *The Forest People* (1968).

[5] For example, Turnbull describes how Mbuti hunter-gatherer youth spend hours rehashing and improving upon the arguments, especially the failed arguments, they have heard among their elders. See Colin Turnbull, "The Ritualization of Potential Conflict Between the Sexes among the Mbuti," in E. Leacock & R. Lee (Eds.), *Politics and History in Band Societies* (1982), 133-155.

[6] For evidence concerning the educational value of age-mixed settings in our culture, see Peter Gray & Jay Feldman, "Playing in the Zone of Proximal Development: Qualities of Self-Directed Age Mixing Between Adolescents and Young Children at a Democratic School," *American Journal of Education, 110* (2004), 108-145. For evidence concerning the value of age mixing in hunter-gatherer and other traditional cultures, see: Melvin Konner. "Aspects of the Developmental Ethology of a Foraging People," in N. Blurton-Jones (Ed.), *Ethological Studies of Child Behavior* (1972); Beatrice B. Whiting & James W. M. Whiting, *Children of Different Worlds: The Formation of Social Behavior* (1988); Barbara Rogoff, *Apprenticeship in Thinking: Cognitive Development in Social Context*

(1990); and Jean Lave & Etienne Wenger, *Situated Learning: Legitimate Peripheral Participation* (1991).

[7] W. Thomas Boyce & Bruce J. Ellis, "Biological sensitivity to context: I. An evolutionary-developmental theory of the origins and functions of stress reactivity. *Development & Psychopathology, 17* (2005), 271-301.

[8] For reviews of the large body of evidence that learning and creativity are facilitated by a playful mental state and inhibited by an anxious state, see: Theresa Amabile. *Creativity in Context: Update to the Social Psychology of Creativity* (1996); F. Gregory Ashby, Alice M. Isen, & U. Turken, "A Neuropsychological Theory of Positive Affect and Its Influence on Cognition." *Psychological Review, 106* (1999)*,* 529-550; and Barbara L. Fredrickson, "The Role of Positive Emotions in Positive Psychology: The Broaden-and-Build Theory of Positive Emotions." *American Psychologist, 56* (2001) 218-226.

[9] Paul E. Spector, "Employee control and occupational stress," *Current Directions in Psychological Science, 11* (2002), 133-136.

[10] Tim Ingold, "On the Social Relations of the Hunter-Gatherer Band," in R. B. Lee & R. Daly (Eds.), *The Cambridge Encyclopedia of Hunters and Gathers* (1999).

[11] David J. Glew, Anne M. O'Leary-Kelly, Ricky W. Griffin, & David D. Van Fleet, "Participation in Organizations: A Preview of the Issues and Proposed Framework for Future Analysis - Special Issue: Yearly Review of Management," *Journal of Management* (1995, Fall). For discussions of one school's long, successful experience with democratic governance, see Daniel Greenberg (Ed.), *The Sudbury Valley School Experience*, 3rd ed. (1992).

[12] C. Leigh Broadhurst, Yiqun Wang, Michael A. Crawford, Steven C. Cunnane, John E. Parkington, & Walter F. Schmidt, "Brain-Specific Lipids from Marine, Lacustrine, or Terrestrial Food Resources: Potential Impact on Early African Homo Sapiens," *Comparative Biochemistry & Physiology, Part B, Biochemistry & Molecular Biology, 131* (2002), 653-673; Ingred B. Helland, Lars Smith, Kristin Saarem, Ola D. Saugstad, & Christian A. Drevon. "Maternal Supplementation with Very-Long-Chain n-3 Fatty Acids During Pregnancy and Lactation Augments Children's IQ at 4 Years of Age," *Pediatrics, 111* (2003), e39-44; and Joseph R. Hibbeln, John M. Davis, Colin Steer, Pauline Emmett, Imogen Rogers, Cathy Williams, & Jean Golding (2007) "Maternal Seafood Consumption in Pregnancy and Neurodevelopmental Outcomes in Childhood (ALSPAC Study): An Observational Cohort Study," *The Lancet, 369* (2007), 578-585.

[13] Tiffany Field, *Touch* (2001).

[14] David Geary, "Educating the Evolved Mind: Conceptual Foundations for an Evolutionary Educational Psychology," In J. S. Carlson and J. R. Levin (Eds.), *Educating*

the Evolved Mind: Conceptual Foundations for an Evolutionary Educational Psychology, 1-99 (2007).

[15] Louis Liebenberg, *The Art of Tracking: The Origin of Science* (1990).

[16] Douglas W. Carnine, Jerry Silbert, Edward J. Kame'enui, & Sara G. Tarver, *Direct Instruction Reading*, 4th ed. (2004).

[17] Dennis D. Embry, Community-Based Prevention Using Simple, Low-Cost, Evidence-Based Kernels and Behavior Vaccines, *Journal of Community Psychology, 32* (2004), 575-591; Dennis D. Embry & Anthony Biglan, "Evidence-Based Kernels: Fundamental Units of Behavioral Influence." *Clinical Child and Family Psychology Review, 11* (l2008), 75-113.

[18] Peter Gray & David Chanoff, "Democratic Schooling: What Happens to Young People Who Have Charge of their Own Education?" *American Journal of Education 94* (1986), 182-213; Daniel Greenberg & Mimsy Sadofsky, *Legacy of Trust: Life after the Sudbury Valley School Experience* (1992); Daniel Greenberg, Mimsy Sadofsky, & Jason Lempka, *The Pursuit of Happiness: The Lives of Sudbury Valley Alumni* (2005). For more on the Sudbury Valley School and a list of schools modeled after it, see http://www.sudval.org.

[19] For one example of such regret, see Hillary Rodham Clinton, "An Idyllic Childhood," in S. A. Cohen (Ed.), *The Games We Played: A Celebration of Childhood and Imagination*. (2001).