INTRODUCTION

This section of the training program will provide evidence from a convergence of findings in the evolutionary and brain sciences to show that many of our current arrangements for learning are based on limited or even faulty assumptions about how the brain naturally functions, and how young people become responsible adults. The second part of this section will outline what a model of learning based on recent findings on the nature of human development might actually look like. Along the way you will be asked to pause and consider some of the issues we have raised.

We will start with two simple assertions: humans are born to learn and learning is what we are better at than any other species. These old and essentially intuitive insights are now supported by the new biological understandings yielded by brain imaging technologies developed since the late 1980s. Non-invasive brain mapping has enabled researchers to watch learning occur as specific patterns of activity within the brain light up on a computer screen.

Today, the brain is seen as a collection of specialized and complex systems (modules), each engineered by natural selection to aid our species in decision-making. Humans are predisposed to learn from and adapt to their environment. We humans are social strategists par excellence, and our social behavior is apparently unique in the degree of its plasticity. In order for us to survive as a species we have evolved to be the planet’s pre-eminent learning species. Because of our underlying adaptation for learning the human brain is a flexible, self-adjusting, biological system which grows and reshapes itself in response to challenge, or withers through lack of use. Predispositions refer to humanity’s universal inheritance, while each individual brain is as unique as the human fingerprint - we are a beautiful mix of nature and nurture.

From the first cell division, brain development is a delicate balance between genes and the environment, and it is only by understanding each of these subtle interactions that we can appreciate the degree to which heredity and life-experiences make us who we are. This is an exciting time because we are now in a position to begin mapping new models of learning that go far further than those we’ve inherited from the limited science of behaviorism and the economic and social needs of industrialism. At the beginning of the 21st century we now have a number of powerful explanations as to how it is that the human race has emerged as the planet’s pre-eminent learning species. The neurologist Marian Diamond captured the excitement of the times when she observed that, “In the 1990s, researchers made remarkable gains in understanding how a child’s brain develops, grows and produces uniquely human capacities. At the same time, they discovered new ways to foster greater intelligence by nurturing brain growth during its most active phase.”

According to the neurobiologist Lise Eliot, “Neuroscience has made tremendous strides over the last quarter century. Powerful techniques now allow us to visualize every part of the living brain in action, from the largest circuit down to the tiny gap between neurons, the synapse; to record electrical activity from single molecules in the brain; and to pluck out, from the enormous haystack of human DNA single genes involved in early neural development, mental retardation, and senile dementia, to name just a few neurological phenomena.” Eliot goes on to note, "Babies are not ‘blank slates’ at birth. They come into the world with all kinds of mental skills and predispositions, abilities suited to the critical needs of early life...Babies’ brains are learning machines.”
So if humans are naturally gifted learners, we might ask, why does today's environment seem antithetical to productive learning for so many children? How is it that something like a quarter or even a third of the population in England and the United States are now functionally illiterate and innumerate? Why do schools need more controls and incentives than ever before to get children to learn those skills and values that civilized democratic society holds dear? Why do so many children seem alarmingly deficient in their ability to generate their own ideas and learning opportunities? Why do so many teenagers complain of being bored? The biology of learning is providing some powerful answers that, in turn, raise serious questions about our largely unlimited faith in current institutional arrangements being able to prepare children for life in the open, free, dynamic societies of the 21st century.

THE OUTLINES OF A NEW MODEL OF LEARNING

It is now possible to begin mapping new models of learning that "go with the grain of the brain." Central to such brain-friendly models of learning is constructing a bridge between the dichotomy of the mind as an inflexible biological product (the position of IQ test advocates) and the mind as an endlessly malleable social product (the position of behaviourists). Such a bridge is possible by merging findings from the brain and cognitive sciences into an evolutionary framework. The point here is that if those working to improve the direction of education don't have a good grasp of where we come from as a species then it will indeed be difficult to chart an effective course for where we want to go. Each generation is not simply starting from scratch.

Archeology helps fill in some of the blanks. For example, while brain tissue disintegrates rapidly after death, archeologists have found skulls from different epochs of human evolution, and by studying their internal shape and size they can draw reasonably firm conclusions about brain growth over the millennia. It is possible to go even further. By analyzing the artifacts left behind by our ancestors, and by relating these directly to the shape of their skulls, we can begin to plot the growth of the intellectual powers of early humans. For example, we know from skull size, bodily remains and the number of artifacts left behind that Cro-Magnons of more than 30,000 years ago were, in terms of intellectual and physical capabilities, us.

According to Ian Tattersall of the American Museum of History Cro-Magnons we are physically "indistinguishable from living Homo sapiens; and, in richness and complexity, the surviving material evidence of their lives indicates unequivocally that they were our intellectual equals." This evidence argues that humans have been learning and teaching each other for more than 1,500 generations, and because of this fact we have thrived as a species.

The evolved nature of the brain does not so much constrain as it creates or enables. For education to go with the inherited basis of brain function, then the learning needs of young people must be seen in terms of both the culture and the accumulated evolutionary experience previous generations found useful to their survival. This means that we need to focus as much on trying to understand the internal structures and processes of children's minds as we do on the knowledge we wish to share with them through the curriculum. For those of us trained in the social sciences, this is a radically different way of viewing human development. Culture (which curricula are designed to
support) is critically important, but it has to be seen in light of human evolution. Ask yourself, "If culture creates the individual, what then creates culture?"

Philip Tobias, the director of the University of Witwatersrand’s paleo-anthropology unit in South Africa, captured the balance when he wrote: "The brain-culture relationship was not confined to one special moment in time. Long-continued increase in size and complexity of the brain was paralleled for probably a couple of million years by long-continued elaboration and 'complexification' of the culture. The feedback relationship between the two sets of events is as indubitable as it was prolonged in time." Brain-friendly models of learning require an implicit balance between our evolutionary inheritance and the culture that education is designed to support. "Each brain not fully utilized is two billion years of evolution wasted."

Evolution, we now understand, has provided humans with a powerful toolkit of predispositions that go a long way in explaining our ability to learn language, to cooperate successfully in groups, to think across problems, to plan for the future, and to empathize with others. Predispositions provide individuals with a whole range of skills that enable them to relate flexibly to their environment. Yet, because for most of human history Man tended to live in relatively small groups, these skills have to be developed collaboratively, as very few people ever possess all these attributes. The speed with which our predispositions evolve seems to be incredibly slow, and it is thought there have been no major changes in the last 30,000 years.

THE LANGUAGE PREDISPOSITION

Human nature matters enormously in learning. For the vast majority of time homo sapiens' experience of living as a wandering tribe in the ancestral environment shaped the broad structures of our predispositions (which encapsulate various successful evolutionary adaptations). These subsequently have been recreated in the brains of every succeeding generation. Thus, what served the purposes of our ancestors are still with us. Both with regard to language and social skills the young child who could not talk effectively, or empathize with other children, would not have been able to survive when the group moved around; its genes would simply have perished. Language and social empathetic skills therefore need to be seen in a survival context. The critical lesson from the evolutionary sciences is that all human development is an intricate interplay; "nature and nurture don't compete, they cooperate."

For reasons that are still not totally clear, the human brain started to grow very rapidly about 100,000 years ago. Some evolutionary biologists and linguists have advanced the theory that there is a direct connection between our ability to develop symbolic thought, to use language, and the growth of the prefrontal cortex, the frontal part of the brain that processes language and abstract thought. As the brain has grown, so has the skull. This has produced a biological "bind" - the child's head has increasing difficulty passing down the mother's birth canal. Because of this, human babies - unlike the young of most other species - are born with their brains incompletely formed and so much brain development, which in other species takes place in the womb, has to take place post-birth. It is partly for this reason that the human infant is far more vulnerable for a greater peri-
od of time than the young of other species. Nature has compensated for this dependency by equipping every newborn child with an amazing set of predispositions to learn. The full understanding of these predispositions is critical to our appreciation of the human potential to learn.

In the 1950s the linguist Noam Chomsky argued that language was simply too complex for each individual brain to learn it from scratch. Without a stumble, the average person can produce 150 words a minute, each word selected in milliseconds from as many as 50,000 possibilities and arranged in a meaningful sequence dictated by an elaborate mental stylebook of grammar and syntax. It is amazing. Work on the nature of language development from Chomsky onwards contends that each brain is born with the predisposition to learn language in a particular, natural way. Our brains owe their basic design to our genetic program. Thus, language is hereditary, and the brain is no clean slate as regards language development. A more appropriate analogy is closer to an old-fashioned gramophone record needing a layer of wax removed from its surface before revealing its preformed structure. The "wax" is removed by the child being exposed to the language. Subsequently, virtually every child born today has the innate capability of recognising about 100 sounds - quite enough to combine in various forms to create all the alphabets in each of the earth's 5,000 plus languages. The neurological structures that make the acquisition of language possible are identical to all human beings, regardless of culture.

Newborn babies can tell the difference between 'pah' and 'bah.' By four and a half months of age an infant 'understands' the significance of clauses; at 10 months the ordering of noun and verb phrases fit in sentences. Below 18 months babies learn the meaning of new words at about a third of a word a day; from then onwards it speeds up to about ten words a day. By listening to the language spoken around them, children set the rules appropriate to their own language by 18 months of age, and in many instances earlier. Bénédicte de Boysson-Bardies, Director of Research in the Experimental Psychology Laboratory at the Centre Nationale de la Recherche Scientifique in Paris notes, "The child is therefore born with an implicit knowledge of the universal principles that structure language and with a genetic program for its acquisition. But for this program to operate, the child needs to hear speech. Human newborns must acquire their language; without linguistic information, their initial biological abilities remain unexploited."

What this means is that, "All humans of normal intelligence can learn any language provided they start at a very young age. After the age of five or six, a child can almost never become perfectly fluent in a language, and the ability to learn it can completely disappear soon after that. After puberty, it is almost impossible to perfect the pronunciation of a second language." As the Italian geneticist Lugi Luca Cavalli-Sforza notes about this fact, "This is an excellent reason to begin foreign language instruction in elementary school, but few governments seem to have noticed this virtually absolute rule."

The brain is essentially economic. What is not needed in one generation is replaced by a more appropriate function. A native speaking Japanese will not have the equivalent of an L or R sound in his or her own language. Attempting to learn to speak English at the age of 15 or 20 will present a Japanese person with an almost impossible task of correctly articulating these sounds. The ability has just disappeared. It is for this reason that no matter how hard you work at learning a foreign language as a young adult or an adult you will always have an accent discernible to native speakers.
COLLABORATION IS A SURVIVAL SKILL

Another predisposition that researchers are beginning to understand far better is that of social skills. Even though it may seem counterintuitive to those of us living in an era that glorifies individualism and cut-throat competition it seems that we humans are predisposed to friendliness and cooperation. Human survival is almost totally dependent on relationships with other people. Faced with a hostile environment, our ancestors banded together to achieve as a group what they could not do alone, just as our communities, businesses, and nations are tied together in networks of mutual cooperation and dependency today. Our Stone Age forebears survived by cooperating with one another in relatively small groups.

They found safety in numbers, but only to a certain extent. Today, amongst tribes in the Brazilian rain forests groups of over 12 or 14 fighting men (with women, children and dependent relatives that means a group of 50 or 60 people) either divide of their own peaceful volition or split through bloody rivalry. Evidence from England in the thousand years before the industrial revolution suggests that most people lived within groups of less than 12 or 13 people. Psychologists state that no one is ever likely to grieve deeply for more than 12 people in a lifetime; it is as if there is a ceiling beyond which our hearts don’t break anymore. As any musician, actor thespian or team athlete can attest, we work best in relatively small self-supporting groups.

Children reflect strongly the predisposition to be social, collaborative and problem-solving in groups through play. It was an intriguing early insight that created the word 'toy,' for this linguistically is the diminutive for the word 'tool.' Without the proper stimulation of social skills individual children found survival difficult in earlier times. For if they couldn’t empathise they would have been left behind when the tribe moved along. Evidence is accumulating to show that the predisposition towards such empathetic activity is at its strongest below the age of six. If collaborative skills are not valued by that stage then the networks are better replaced with 'other' skills that could be useful, such as the behaviour of the isolate and the dependent, or a simple regression towards violence.

With all this evidence available it seems curious that education systems still place children in classes of 25 or 30 students at the age of five, and high school students into schools of 1500 pupils or more. Young people react to this impersonal scale by immediately forming into more cohesive units of friends with similar views and interests. Go to any high school and you will see packs of athletes, scholarly-types, beauty-queens, burnouts (those who smoke), and numerous other subgroups and cliques. Children find out about themselves by measuring themselves against the standard of their group mates. They come to think well or poorly of themselves by judging how they compare with the other members of their own group.

The American commentator Judith Rich Harris takes this point even further when she argues, "the culture acts upon children not through their parents but through the peer group. Children’s groups have their own cultures, loosely based on the adult culture, and it’s impossible to predict what they’ll include. Anything that’s common to the majority of kids in the group may be incorporated into the children’s culture, whether they learned it from their parents or from the televi-
Rich Harris' point adds a new twist to the old adage "it takes a village to raise a child." Her research argues that individual parents are greatly limited in how much influence they have on children while adults as a collective are vastly influential. Rich Harris asserts, "Although individual parents have little power to influence the culture of children's peer groups, larger numbers of parents acting together have a great deal of power, and so does society as a whole. Through the prevailing methods of child rearing (society) fosters, and through influences - especially the media - that act directly on peer-group norms and values, a society shapes the adults of the future. Are we shaping them the way we ought to?"

Ronald Kotulak, in his Pulitzer Prize winning series of articles on violence and young people for *The Chicago Tribune* adds a neurological spin to the importance of developing young people's social predispositions when he warns that, "By failing to provide young children with the supportive and nurturing environments in which they can develop their predispositions towards social, collaborative and team-building skills, young children's brains react with astounding speed and efficiency to the violent world they experience around them by rewiring trillions of brain cells that literally create the chemical pathways for aggression." If Kotulak is right aggression, rather than conciliation, becomes the action of first response. "He disses me in front of my homeboys so I popped him," is the sort of simple explanation police officers across America have grown accustomed to hearing as the reason for why a young person kills. Nurture (in this case a peer group that has a complete disregard for human life) has the power to modify nature in each succeeding generation.

Even if we don't study the extremes that Kotulak did, there is much evidence to worry us deeply. It is highly likely that there is a direct connection between the child who was not encouraged to use his or her innate desire to collaborate in the earliest years of life, and the young graduate who is the despair of his first employer who is staggered to find that after 16 years of formal education he/she can't think for themselves, can't work in a team, and has to be told what to do. Developing such collaborative higher order skills at the age of 23 or 24 is infinitely harder, and more expensive, than developing them with the grain of the brain at age five or six. Isolation is a learned behaviour, and in the world of hypermedia, and in particular the world wide web, it is considerably easier than at any other time in history to live as a loner completely disconnected from the physical world of other people.

In light of this evidence it is disturbing that at the beginning of the 21st century, a time when the richest countries are richer than ever, more than 22 percent of children under the age of 18 in America live in relative poverty, while one in five children in England live below the poverty line. This is not, however, to argue for the expansion of the nanny-state where young children spend most of their waking hours in formal institutions at ever younger ages, but rather to reason that children need the time of their parents and other adults in neighbourhoods and communities that care. This requires a shift in societal values. It calls for dealing with not just issues related to the school, but to those of the family, community, housing, health care, and most profoundly to an appreciation of the spiritual.

It may seem counterintuitive to argue that to improve children's learning we need to focus less on schools and more on what children do outside of it. "Surely schools are more important in the
education of children than parents and the community?" many people would reason. But consider
the following piece of research from the Kellogg Corporation’s Learning Now program; the "con-
clusion was based on research conducted in Michigan, which compared the relative influence that
family, community, and other factors have on student performance. Amazingly, it concluded that
factors outside of the school are four times more important in determining a student’s success on
standardised tests than are factors within the school … this reaffirmed, for those of us in business,
the importance of becoming partners with educators, parents, and other institutions in our com-

munity dealing with the development and performance of young people. What this means is that
business people cannot just sit on the sidelines and criticise but, rather, we must be involved.”

In the very recent past young parents were supported by extended family and neighbours, and in
hindsight this was a much more effective system of inculcating children into a culture and set of
shared values than any subsequent formal government program. How can intergenerational
human support networks be encouraged and supported in the 21st century is what those con-
cerned not only about improving the learning skills of young people, but also keeping civilized
society together, need to ask themselves?

Formal education has a role to play. As children enter primary school there are great advantages in
allowing them the opportunity and space for productive play and social interaction. Consider the
Japanese approach to early years education. According to Catherine C. Lewis, an American educa-
tor who lived and worked in Japan while her two sons attended Japanese schools, the high aca-
demic achievement of Japanese students is not a result of their highly regimented secondary school-
ing. Rather, it is due to Japanese society meeting "children’s needs - for friendship, for belonging,
for opportunities to shape school life." Lewis wrote:

- Japanese kindergartens center on free play, not academic instruction. Japanese kinder-
garteners spend almost four times as much time in free play as their American counterparts.
- Japanese elementary schools emphasize kindness, collaboration and persistence - not test
scores. Without ability-grouping or tracking, Japanese children cooperatively master a chal-
 lenging academic curriculum.
- Japanese students assume much authority. Even first-graders quiet their classmates, help
solve disputes, lead class meetings, and shape class rules and activities.
- Small groups are at the heart of elementary school life. The four or so members of a group
together pursue a wide range of activities - from art to lunch to science. Only when small
groups become ‘like families’ do teachers expect learning to occur.

There are other innate predispositions that are informative. We know, for instance, that there are
critical periods for the development of numerical skills, and for different forms of musical appreci-
ation. It is fascinating to learn that two of the countries that most stress the teaching of music
for young children - Japan and Hungary - consistently score well in mathematics on the
International Mathematics and Science Survey. This is true even though Hungary spends far less
on elementary and secondary education that most countries in the Survey. As a guiding principle
for those working on more effective models of learning it is likely that the more we come to
understand these predispositions, the more we will come to appreciate how different evolutionary
traits from long past have shaped our preferred ways of doing things. Amongst these has to be the recognition of the significance of emotion in providing a short circuit in the way in which the brain responds to those things of high emotional interest - a vastly different set of innate responses to those of more logical and abstract significance.

The role of the amygdala will receive increased attention. This almond shaped section of the limbic system within the brain regulates our aggressions, emotions and sex drive by intentionally bypassing the brain's carefully constructed logical functions. The existence of an override mechanism is an important clue to the nature of learning for it indicates a primacy of emotion above logic in driving attention spans, shaping action and aiding memory retention. "The emotional aspect of development is in many ways the most important one of all, because it establishes the critical foundation on which every other mental skill can flourish. Well before they master language, babies communicate through emotional expression, and it is through these interactions that they develop the security, confidence, and motivation to master their more obvious motor, verbal, and cognitive achievements."  

Pause and consider the following questions
1) In trying to shape "a culture of learning" what might be the role of parents, schools and the larger community? How could such roles be better facilitated by you?
2) How can educators help themselves and the general public understand that the process of learning (making valid connections between ideas and facts) is as significant as what is learnt (content)?
3) How could an appreciation of the "language predisposition" be used to benefit children in your community/school?
4) Can a better appreciation of "group size" improve the learning of children in your community/school? If so, how?
5) If factors outside of the school are four times more important in determining student academic achievement why does politics increasingly focus on issues related to schools and teaching? How can this focus be better balanced?
6) What are some of the possible difficulties one might face in trying to merge research findings from different fields of study? How can these difficulties be overcome?
7) How can communities and schools do a better job of tapping into the research and experience emerging from different parts of the world? How can they make it "user-friendly" in the context of their own environment?

Additional recommended readings
A BALANCE BETWEEN PREDISPOSITIONS & THE "PLASTIC BRAIN"

Education must work to develop new possibilities. The first step towards the possibility of more effective models of learning is to develop an approach that exploits the findings in developmental psychology, cognition, the physiology of the brain, and the evolutionary sciences. Taken together, findings from these fields now offer a rigorous body of evidence that goes well beyond the limited assumptions behind current models of education. By taking advantage of our intellectual and social predispositions education can more effectively empower young people to build on their inheritance as the planet’s pre-eminent learners. In truth, this is a difficult challenge that requires a thoughtful debate between policy makers, researchers, educators and the general public.

For example, argument rages as to the relative significance of inherited predispositions, and a constructivist theory of learning. Within neuroscience the constructivists build much of their case around the concept known as brain plasticity. The basic idea is simple. We make our brain as we use it. Its very shape and the efficiency of its processing is a measure of the way we operate. The more we use our brain the more usable it becomes. Even a brain at quite an advanced age can learn to do things that at an earlier stage were seen as quite impossible. What is most significant, however, is that the process of learning is more difficult than if it is being attempted during a window of opportunity offered through inherited predispositions, e.g. the learning of a foreign language.

Brain plasticity, according to Susan Greenfield of Britain’s Royal Institution, is central to individuality. She reasons, “As the brain becomes more sophisticated, it appears to exploit instinct (predispositions) less and less and instead uses increasingly the results of individual experience, of learning. Hence individuality, I would argue, becomes more evident: the balance starts to tip correspondingly away from nature toward nurture - the effects of the environment.”

This concept of brain plasticity is advanced further by researchers at the Salk Institute in La Jolla California who argue that “as we build networks and patterns of synaptic connections when we are very young so we build the framework that will ‘shape’ how we learn as we get older; such shaping will significantly determine what we learn - it will be both an opportunity, and a constraint. The broader and more diverse the experience when very young, the greater are the chances that, later in life, the individual will be able to handle open, ambiguous, uncertain and novel situations.” From this perspective, early years learning guides later development, and transforms the learning device itself. Thus what has been learned can influence future learning. The brain, from this perspective, is seen as a highly malleable self-adjusting organism in the earliest years, but over the course of a lifetime the brain’s ability to learn is at least partially constrained and channeled by earlier life-experiences.

The Hollywood children’s advocate Rob Reiner has taken this evidence on brain plasticity and the significance of early years learning to lead a campaign in the U.S. that focuses on promoting early childhood development issues. Reiner’s campaign made it to the White House where President Clinton and the First Lady convened a conference on early years learning in April of 1997. Reiner told the White House gathering: "If we want to have a real significant impact, not only on children’s success in school and later on in life, healthy relationships, but also an impact on reduction
in crime, teen pregnancy, drug abuse, child abuse, welfare, homelessness, and a variety of social ills, we are going to have to address the first three years of life. There is no getting around it. All roads lead to Rome.30

This position is supported by many in the neurosciences. Marian Diamond of California Berkeley argues, "The emerging message is clear. The brain, with its complex architecture and limitless potential, is a highly plastic, constantly changing entity that is powerfully shaped by our experiences in childhood and throughout life."31 Joel Davis, in Mapping the Mind, takes the opportunities of early childhood even further when he argues, "The great window of learning opportunity for the human brain clearly appears during the childhood years, especially up to about the age ten." But, he adds a point about plasticity, "that doesn't mean that we - or our brains - are over the hill after that point...In fact, it doesn't matter how old our brains are - 15, 25, or 50 years old, or more. As long as we stay healthy and active, the brain will retain some of its plasticity, growing more dendrites and axons and forging new connections among them.32

Ann B Barnet, professor emeritus of neurology at George Washington University School of Medicine adds, "Human babies are born helpless, and they stay helpless for a long time. They arrive expecting to be cared for and protected. They are born to learn, and their ability to learn - to make adaptive changes in their behavior on the basis of experience - is at its peak in the early years of life, when they are making the brain connections on which learning and living depend. To be sure the brain has remarkable capacities for self-protection and recovery. But the loving care and nurture children receive in their first years - or the lack of these critical experiences - leaves lasting imprints on young minds."33

The significance placed on the first few years of life has its critics. According to the cognitive scientist, John Bruer, the prominence given by many in policy positions and public relations to the concepts of "early periods of development, windows of opportunity or critical periods" is largely misplaced and in danger of leading to an ideology of infant determinism. Bruer believes such claims have led prematurely, at least in the United States, to "high-level justification for better prenatal, postpartum, and pediatric care; family planning; welfare reform; parent education; and high-quality day care and early childhood education."34 Even further, Bruer fears, some believe that: "We need to change our child rearing practices, we need to change the malignant and destructive view that children are the property of their biological parents. Human beings evolved not as individuals, but as communities ... Children belong to the community, they are entrusted to parents."35 From this perspective, Bruer argues, there is a real danger of the emergence of a highly intrusive nanny-state.

Bruer argues that findings from the neurosciences do not support these efforts, and are based on nothing more than "myth." In his book The Myth of the First Three Years, he says: "The jury is still out about the importance of the first few years of life. While the early years are no doubt important, it remains unclear just how important."36 Bruer goes further. "The odds that our children will end up with appropriately fine-tuned brains are incredibly favorable, because the stimuli the brain expects during critical periods are the kinds of stimuli that occur everywhere all the time within the normal developmental environment for our species. It is only when there are severe genetic or
environmental aberrations from the normal that nature's expectations are frustrated and neural development goes awry."

The danger of infant determinism, argues a writer for The New Yorker magazine, is that it could lead to a justification for short-changing the needs of older learners. "Why bother spending money trying to help older children or adults if the patterns of a lifetime are already irredeemably, in place? Inevitably, some people will interpret the zero-to-three dogma to mean that our obligations to the disadvantaged expire by the time they reach the age of three."

LIFELONG LEARNING STARTS AT BIRTH

The 21st Century learning Initiative argues that the preparation for lifelong learning starts, whether we recognize it or not, at the very beginning of life. This does not mean we do not appreciate the significance of learning in later years. In fact, we believe just the opposite. We believe that if the groundwork is properly developed for lifelong learning in the earliest years then older children will actual benefit by being able to take more responsibility for their own learning.

Ideally, children's learning should be supported by a loving and committed nuclear family reinforced by the extended family, neighbors, and the immediate community. This traditional arrangement is under threat (or has disappeared) for many. Nevertheless if the goal of education is to extend the brain's natural inquisitiveness then the youngest children need an environment that offers them stability, challenge, values and cohesiveness that we attribute to functional loving families. It is through constant support and appropriate stimulation that the learning predispositions of the youngest children are effectively nurtured. These predispositions are so powerful that children, if they are not in a degraded environment, are going to find things out for themselves. As John Bruer notes above, children learn whenever and wherever they are stimulated; just what they learn is problematic.

A society careless about children's informal learning experiences has forgotten how children are inducted into adult society. By the time an American child is 11-years old, according to the American Psychological Association, he or she will have watched over 100,000 acts of brutality on television. In the United States one-third of all children live apart from their fathers and at some point during their childhood more than half will experience the absence of their fathers. The far too common occurrence of missing fathers has a particularly damaging effect on boys. A sense of direction and purpose is where the origins of intrinsic motivation begins for children. That is what keeps them going when times get tough. It is an inner strength. Without it youngsters all too easily get bored, cynical and disillusioned. Children need to know where they belong.

For children to be successful learners they need to be part of a community of motivated and successful learners. The reason for this can be found in the statements of Jerome Kagan who observed: "The concept of relative fitness in evolutionary biology assumes that the success of any one individual or species in a locale depends not only on its genes and biological-behavioral characteristics but also on the competences of the other individuals or species living in the same eco-
logical niche with whom it competes." Note carefully the last part of that sentence; we do not live in isolation, part of our intellectual strength comes from others around us. Kagan goes on to explain what this means for children when he reasons "the quality of the school, the motivation of the teachers, the values of peers, the mores of the neighborhood, and the child's identification with his socioeconomic class will exert important influence during the childhood years." We argue that developing young people who excel as life-long learners require the involvement of the whole community; it has its own immediate feedback; children and adults working together stimulate community regeneration as well. We call reconnecting community with the learning needs of children "turning education systems inside out" because the locus of learning has now to extend well beyond just the classroom.

ADOLESCENCE AS A PREDISPOSITION

Very young children are born dependent on adults to provide an environment that supports their intellectual, emotional and social predispositions. There is an increasing amount of evidence to support the argument that adolescence is a biological predisposition to break away from dependence on adults. This is not to say that adolescents do not need the support of older people, but rather to say that they need to be held increasingly responsible for themselves and for others. Unfortunately, teenagers spend much of their time under the control of formal institutions that strive to deal with them uniformly. Just when adolescents are seeking to find their place and role in society they are largely at the mercy of a battery of bureaucracies. Chief among these are public schools that have become increasingly large and impersonal.

The University of Chicago psychologists Mihaly Csikszentmihalyi and Reed Larson wrote in 1984, "that in all societies since the beginning of time, adolescents have learned to become adults by observing, imitating, and interacting with grown-ups around them. The self is shaped and honed by feedback from men and women who already know who they are, and can help the young person find out who he or she is going to be. It is startling how little time these teenagers spend in the company of adults." In one of the largest survey's of young people ever taken the New York-based Public Agenda Foundation noted in late 1999 that 42 percent of teenagers "feel bored every day or almost every day," and 74 percent spent their free time just getting "together with friends to hang out without anything specific to do." The word "teenager" did not enter the popular English Language until 1941 when it appeared in a Popular Science magazine article. "It seems to have leaked into the language from the world of advertising and marketing, where demographic information was becoming an increasingly important part of predicting which sales approaches are most effective with particular buyers." While modern parents and teachers may find teenagers disruptive and even dangerous, earlier cultures directed adolescent energy in ways that benefited the life of the community, and strengthened those skills on which the community was dependent for its ongoing survival. Adolescents were needed, and in particular adolescent males were needed. In providing clear definitions of what was required of adolescents, adults of an earlier age ensured that young people learned, and practised, what was seen as appropriate and useful social behaviour.
At an international conference on Children and Families, Guido Walraven of the Netherlands noted: "Development to adult life is the emancipation of young people from their parents, earning their own place in the family and society at large. This process used to be more a matter of course than it is nowadays. Rituals denoting transition were culturally established (in French or in bilingual Canada this is called 'rites de passage'). Today's society offers young people much less opportunity to win a clear place. Compared to the old days, society no longer seems to need its young people. That has great effects on the emancipation process or the transition to adult life. For instance in some ways the period of adolescence is becoming longer, because becoming independent and having your own job and family tend to happen at a later age, while in other ways some children, especially children at risk, grow up at an early age, that means that by force of circumstances they have to stick up for themselves and to fight as adults."

The transition from childhood to adulthood is fraught with dangers, and this is especially true for young people who have not developed the ability to think for themselves. So far, science knows far less about the neurological changes at this stage of life than it does about the predispositions that operate roughly below the age of seven. However, in the first study of its kind, in 1998 researchers at McLean Hospital in Massachusetts used findings from fMRI of adolescent brains to show definitively "age-related physiological changes in the brains of adolescents which may help explain the emotionally turbulent teenage years. (From this they concluded that) adolescents are more prone to react with 'gut instinct' when they process emotions, but as they mature into early adulthood, they are able to temper their instinctive 'gut reaction' responses with rational, reasoned reactions. Adult brains use the frontal lobe to rationalise or apply brakes to emotional responses. Adolescent brains are just beginning to develop that ability."

Effective models of education have traditionally taken advantage of these emotionally charged years by channelling this energy into powerful mental and physical challenges. In England's recent past, this meant international expeditions of groups of young people to rugged areas such as uninhabited islands or mountain regions. In the United States it has meant summers building houses and churches in less developed areas. Teenagers thrive in such challenging activities, and as any adult who has ever worked with such groups can attest it is amazing how they can spend 12 hours on backbreaking work and still stay up half the night talking to each other. This is the energy of adolescence that is all too often wasted, or even worse, misapplied.

From an evolutionary perspective there must be a reason for the emotional surge in adolescent energy. Earlier societies saw adolescence as a period of great potential, as well as one of turmoil. Such societies knew how to use the desire of adolescents to show mastery of certain skills to extend and improve the welfare of the community. The natural tendency of young people when they move into puberty is to reverse their dependency on adults. They want to be in control; not because they want to be bloody minded, but because their new-found strength and emotional energy are pressing them to show that they can now use what they learnt earlier to become fully functional, independent people. In the advanced societies of the 21st century those adolescents not equipped with the survival skills of basic literacy and numeracy, as well as the higher order skills described earlier, are desperately ill-prepared to deal with the physiological changes of adolescence and end up mentally, emotionally and socially adrift.
THE GAME OF SCHOOL

There is no one best way of raising a child. Each family has to figure it out for themselves by balancing the pros and cons of their situations and opportunities. Additionally, in speaking with dedicated teachers from inner-city areas of the United States and the United Kingdom we are constantly told about the "reality" of education in "a post-family era." The only answer we can give is that those who are dedicated to providing more opportunities to young people through education reform need to take the breakdown of the family and community as seriously, or even more seriously, as they do the needs of day-care centers, schools and teachers.

Yet, despite decades of evidence showing that the factors outside the school (family and community) are more important to children's learning than the schools themselves the political response in many countries has been largely to expand the significance of formal systems of learning - more schools, longer hours, higher stakes, more tests...the list is well known. If one looses sight of the increased economic pressures facing families and communities then the problems facing children's learning are easily placed solely on the shoulders of teachers and school administrators. From this perspective schools and teachers have just gone too soft. In contrast, we argue it is necessary to remember that learning is an intensely subjective, personal process that each person constantly and actively modifies in light of new experiences. Learning is an open process, but schools by their very bureaucratic, rigid and hierarchical nature are closed systems. Honestly ask yourself, how many hours did you spend in your formal education sitting in a classroom listening to a teacher drone on while you watched the clock move at a snail's pace, and dreamed about your real interests? This is not a criticism of teachers, but a realization that the closed, rigid and decontextualized setting of a classroom is by its planned nature limiting.

It is for this very reason that much of what is taught in schools does not transfer over into the real world for many children. The educational researcher Lauren Resnick has observed that, "the process of schooling seems to encourage the idea that the 'game of school' is to learn symbolic rules of various kinds, and that there is not supposed to be much continuity between what one knows outside school and what one learns in school. There is growing evidence, then, that not only may schooling not contribute in a direct and obvious way to performance outside school, but also that knowledge acquired outside school is not always used to support in-school learning. Schooling is coming to look increasingly isolated from the rest of what we do."

Yet, despite the limitations inherent in the "game of school" we continue to persist in preparing children for a rapidly changing world by requiring them to simply spend more hours working harder in schools that were themselves designed to an Industrial Age brief. The reason we do this is not because there is a lot of support from scientific research saying this is in the long-term interest of children's learning and development, but rather because adults just don't have as much time for children as they did in the past. Unfortunately for children, this fact clashes with the reality that formal education makes sense to youngsters when they can connect what they learn in school to that which happens outside of it. When it doesn't...when what is learnt in school seems static and conformist then children pay only perfunctory attention to the "game of school."
Pause and consider the following questions
1) How can a deeper appreciation of learning be used to better prepare very young children for a lifetime of productive learning? What should be the appropriate role of professionals and parents?
2) As new information comes out on the significance of early years learning is there a danger of “infant determinism” in your community? Are we seeing the rise of a “highly intrusive nanny-state?” In your view, does your community have an appropriate balance between the needs of the youngest children and the needs of older learners? If not, what can be done to make it more balanced?
3) Does your community/school have a problem dealing with its teenagers? How can the energy of adolescents be channeled to the benefit of themselves, their schools, and their communities?
4) What can participants in this course do to help those “outside” the world of education understand that they have an important role to play in children’s learning?
5) How can “in-school-learning” be better organized to correlate with “out-of-school” learning?

Additional recommended readings

THE PYRAMID MODEL OF EDUCATION

Contrast what we have said about the learning needs of young children, and the predisposition of adolescence with the current model of education prevalent in most countries around the world. There is a common pattern of educational spending. From birth to age five children and parents are pretty much on their own with some assistance for poor families. As children enter the formal education system at age five or six the largest class sizes are when children are at this age; thus, when predispositions are at their most fertile we have children in classes of 30 or more. In secondary school we have ever decreasing class sizes that clash with the adolescent’s increasing wish to be independent at about the age of 14 or 15. Many adolescents, for the most natural of reasons, get completely turned off by schooling at this stage because it simply does not seem real in comparison to the emotionally charged environments they experience away from school with their peers.

We argue this system of education is largely "Upside Down" because there is far more money spent on secondary school students than on primary school students, and there is considerably more expenditure per college and university student than there is on secondary level students. In the United States, for example, average annual expenditure per student in elementary schools is $5,371, in middle school and high school it rises to $6,812, and by university it is $16,262 per student. This funding structure is based on the assumption that the youngest children need less direct support and older children need more. It is just this sort of logic that has supported the model of education depicted as graph one on the following page.
A BIOLOGICAL MODEL OF LEARNING

Even people who think the early years movement has gone to extremes would surely agree there is little evidence from the brain sciences to justify spending three times more on the learning needs of a 20-year old than those of a four or five-year old. The fertile predispositions for learning in younger children, and what is now known about brain plasticity (whatever the balance between them) suggest that it is good public policy to develop a more balanced investment between the learning needs of younger children and those of older students.

We can take this argument a step further and make the case that it is not just about investing more in younger children, but actually investing in such a way that would enable children, as they enter adolescence, to take more personal responsibility for their own learning. This increased responsibility would be in line with the adolescent predisposition to begin taking charge of their life. Such a view of learning is only realistic, however, if adolescents have developed the traditional basic literacy and numeracy skills in tandem with the higher order skill of metacognition - thinking about one's own thinking.

Elementary schools should provide classes for five-year olds of no more than 10 or 12. Teachers should construct learning programs that combine - in the child's mind as well as theirs - an understanding of both content and process in ways which make children's thinking visible to themselves. While good teachers will remain essential it is clear that successful learning for all will require substantially more than just the technology of teacher, chalk and talk. As a policy, we suggest investment in the technologies of learning increasing with the child's age.
Teenagers who are functionally literate and understand how they think and make themselves better learners actually need and want less direct formal classroom-based instruction, and can utilize both the power of information communication technologies and internships in the larger community. Many students in elite secondary schools have already gone beyond their dependence on teachers by accessing learning information on-line, and through community-based resources such as museums, local universities and businesses. Indeed, a group known as Schools Without Walls has developed an entire secondary educational experience around just this model of community based learning resources. A model of learning, building on the skills children acquired during the primary years, that crossed an entire community would provide increased flexibility for older students, and for education systems that increasingly face budgetary constraints and teacher shortages.

The argument we are advancing is that learning is open-ended, as is the neural structure of the brain. This is an important point because in no western country do students spend more than 20 per cent of their waking hours in a classroom. However, within the community at large there are an ever increasing number of early retired people who are fit and strong and have many professional skills and life-experiences. At the moment they are largely wasted in terms of helping young people's learning. Immediately such people do not want to become full-time teachers, but many would be interested in sharing their expertise with young people informally. These are just the people that adolescents need to be able to relate to - almost surrogate grandparents. These people, and others, need to be recruited to work with young people. Now, in the light of what we have said about brain development, predispositions, metacognition, and motivation consider Graph 2 - Intellectual weaning based on normal human development.

**Graph 2: Intellectual Weaning Based on Normal Human Development**

- **Autonomy**
- **Primary education**
- **Secondary education**
- **Tertiary education**
- **Predispositions**
- **Dependency**

*Graph showing the transition from dependency to autonomy across different stages of education.*
Graph two is a visual based on what is currently known about normal human development. The graph would vary slightly for each child (e.g. some children might enter adolescence at 11 while others may be closer to 13). The graph shows that the richness of predispositions in the early years of life call for children to be highly dependent on other people to provide support and stimulation. Over the course of the millennia during which our species developed, this dependence on others was steadily replaced by a growing need to demonstrate that earlier skills had been mastered in such a way that the adolescent became increasingly responsible for his or her own development.

It is easy to transpose onto this graph the cognitive apprenticeship model of learning (described in the Science of Learning section) where maximum support in the development of basic skills is given when children are very young. Subsequent external adult support takes the form of temporary scaffolding held in place only until the young learner is confident enough to move onto higher skills. Greatest adult support is given when the child is young so that, as he or she grows, that support diminishes and becomes more that of a facilitator.

In successful apprenticeship learning there is a continuous underlying theme. The more skills the learner acquires, the more the learner is responsible for using those skills. Learning therefore follows a strict weaning process. But note this; if the opportunity offered by the various predispositions is not seized when children are very young, then the young will struggle to deal with the challenges of adolescence. It is important to remember that in pre-industrial societies weaning was a tough survival principle. There was no way for those young people who were unable to graduate as autonomous learners to survive. In such societies there was no room for people who could not act to the benefit of themselves, their family and their community. There is an obvious lesson here for our times. If we do a better job of maximizing the potential of young children and help them take control of their own learning, then we should begin to see adolescence as an opportunity rather than as a problem to be controlled.

THE CLASH

With the above opportunities in mind for developing models of learning that work with the predispositions of young children and adolescents contrast graph two with what currently happens (graph one) in the school systems of the United States and the United Kingdom. It must again be stressed that the present arrangements for conventional schooling are a reflection of the assumptions about human nature and learning that emerged to support the needs of the Industrial Revolution. When superimposed on the graph depicting Intellectual Weaning it shows a dramatic clash (Graph 3).

The clash reveals the desperately inappropriate provision for the youngest children and goes far in explaining why, as they move into adolescence, many are so ill-equipped to handle the biological and social changes that then hit them. Over the years teachers have come to fear the aimlessness and apparent reckless irresponsibility of so many adolescents. So the call has constantly been for more resources to control youngsters, who are already feeling increasingly sullen and misunderstood.
Adolescents' criticism of teachers and the system, not always well-articulated but always full of passion, is immediately thrown back on them for being uncooperative. At the stage in which they are impelled by their natural predispositions to take responsibility they are inhibited by their lack of early skill development. They become frustrated, disillusioned and awkward. In ways that often seem incomprehensible to worried adults their energies are expended in kicking the system. A century or so ago girls married after menstruation at the age of 16 or so, while boys took up jobs by the age of 14 that eventually gave them the independence to start a family.

Now not only does menstruation begin earlier, to around 11-years of age, but in an effort to protect adult jobs it is now almost impossible to begin a job that offers a living wage until the age of 22 or 23. For an extended period of 10 to 15 years adolescents are neither children nor adults. The media glamorises the 17-year old beauty, while moralists seeking to hold together family values call for a morality based on ever-longer periods of delayed gratification. The biological turmoil is real enough, but the cultural confusion is even greater.
CONCLUSION: ARE WE AT AN EVOLUTIONARY CROSSROADS?

Most conventional school reform has failed to realise its full potential because it attempted to mandate new structures without changing the rules throughout the system. Thus, vast numbers of educational reformers and innovators have seen their best thinking frustrated by the need to fit their innovations into the parameters of the existing system.

Imaginative attempts to help children understand their own learning in elementary schools have almost invariably been minimised by the experience of the secondary school where the pedagogic tradition is different. The flip-side of this is when children attend traditional teacher-centred primary schools, and then enter a high school that is based on open collaboration with peers, experiential learning, making connections between disciplines, and the extensive use of information communication technology. Students who are unprepared struggle to handle their intellectual freedom, and often flounder and risk becoming a potential problem.

An example of dealing with this disconnect between the primary school experience and the secondary school comes from the Illinois Mathematics and Science Academy (IMSA). IMSA accepts students from across the state of Illinois and consistently leads the state of 11 million people in academic achievement. The president of the academy, Stephanie Pace Marshall, observed in early 2000 that many students initially struggle in taking control of their own learning because for the first 10 years of their schooling they were never expected to do so. Old habits are hard to eradicate. The academy compensates for this by providing extra support for first year students, support based on the premise of short-term scaffolding. Students are helped in taking control of their own learning.

What's even more disappointing than the initial transition many entering students face, Pace Marshall says, is that students who excelled at IMSA often find the first couple years of university stifling because they feel constrained by the teacher-dominated form of instruction. This they have to tolerate until, near the end of their first degree, they are allowed to start developing their own programs and artefacts. The freedom to do original research, or create new computer programs, isn't possible until the students enter graduate school. The game of schooling seems a waste of time when young people already know the power of taking control of their own learning, and the pride of creating new ideas, concepts or technical know-how.

At all levels of the education system it seems as if the system is simply reluctant to "let go" of students. It is as if they believe that no learning is taking place unless students are being taught. Rather than weaning youngsters the system seems bent on playing down their ability to do something for themselves. In a variety of subtle, and not so subtle, ways western society has trivialized all levels of young people in the school. Is it any wonder teenagers say they feel bored, uninvolved and often in conflict with a world that tells them what to do, rather than expects them to work it out for themselves?

It is these discontinuities, together with the need to jump through all kinds of hoops, that has led to a call for reversing upside down and inside out systems of education. Without a consistent integrated agenda that seeks coherent change right across the learning experiences of children and
young people, piecemeal change is always going to be disappointing, and the system will go on doing pretty much what it has for the last 100 years.

With the knowledge and experiences currently available it is not an exaggeration to say that societies now stand at an exciting time in human history— at an evolutionary crossroads so to speak. Will we be able to capitalise on the many understandings about learning and brain development so as to harmonise our knowledge about learning with the rapidly changing economic and social needs of post-industrial societies? If we are to rise to the challenge then the unit of change can no longer simply be schools but the larger community. Learning communities would have as their first priority the strengthening of families, and providing for the learning needs of all their young people. All available resources, both formal and informal, would be used towards the goal of helping children become responsible adults who know how to function successfully within a community.

Learning would no longer simply be bound to the walls of a single institution. Rather, it would be seen as a total community responsibility, and individual schools would be seen as responsible to the whole community, not just part of it. From this perspective it is not merely teachers who can teach, it is not just pupils who need to learn, and it is certainly not just the classroom that is any longer the major access point to a range of knowledge, information and skills.

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Pause and consider the following questions
1) Do you accept the argument that your system of education is “upside down” and “inside out”?
   If so, what type of support would you need to make the argument for yourself?
2) If you accept the “upside down” and “inside out” argument who would you need to convince in order to seriously initiate a restructuring of your schools?
3) Does the biological model of learning we have described offer a viable way of addressing the approaching teacher shortage?
4) Who are some of the people in your community who could act as mentors to older students?
   What type of resources and support would these people need?
5) How could learning, as described above, be used to help communities rebuild and strengthen themselves?

Additional recommended readings
ENDNOTES:

3) Ibid.
10) For details refer to Ian Tattersall.
11) Michael S. Gazzaniga takes the concept of predispositions further when he argued in 1998 that, "over the past 30 years the mind sciences have developed a picture not only of how our brains are built, but also of what they were built to do. The emerging picture is wonderfully clear and pointed. Every newborn is armed with circuits that already compute information enabling the baby to function in the physical universe. The baby does not learn trigonometry, but knows it; it does not learn how to distinguish figure from ground, but knows it; does not need to learn, but knows, that when one object hits another, it will move the object." *The Mind's Past*.
15) Ibid.
20) Ibid., p. 95.
26) According to Michael Posner and Daniel Levitin, "there is already evidence of critical periods in the learning of skills. Weber-Fox and Neville (1996) studied the learning of English by immigrants from China who came to the United States at ages ranging from two years to adulthood. They found that the brain circuitry involved in understanding the meaning of lexical items was similar regardless of age of immigration. However, the circuitry underlying grammatical judgments resembled American natives for those who immigrated as young children, but was very different in those whose immigration was late. A similar critical period has now been reported in learning the violin. Children who begin lessons prior to age 12 show changes in somatosensory cortical representations between the left and right hands that are not present even in expert violinists who began their lessons late." In Robert L. Soslo (ed.), Mind and Brain Sciences in the 21st Century. (London: The MIT Press), 1997, p. 97.
35) Bruer quotes Dr. Bruce Perry of the Baylor College of Medicine, p. 15.
36) John Bruer., p. 60.
37) Ibid.
40) Ibid.
more recently Laurence Steinberg's ten year study entitled *Beyond the Classroom: Why School Reform Has Failed and What Parents Need to Do* (1996). Also refer to the success of Home Schooling, for example, "A Home Run for Home Schooling: Movement can point to high test scores in national study," *The Washington Post* (3-29-99). In the United Kingdom refer to Peter Mortimore's 1979 *Fifteen Thousand Hours and Their Effect on Children.*
