INTRODUCTION

It is becoming clear to a growing number of policy makers, business people, educators and the general public in North America, Europe and elsewhere that successful education in the 21st century requires helping all children move well beyond just the traditional goals of literacy and numeracy. Tony Blair touched on this theme during a speech at Oxford University in late 1999 when he urged an abandonment of the mindset that sees education as simply "offering a standardized, monolithic provision for pupils" in favor of moving towards a mindset and educational arrangements that operate under the premise that young people's learning "needs are highly diverse and individual." The Organization for Economic Cooperation and Development (OECD) agrees and argues that, "A lifelong learning approach calls for a sweeping shift in orientation, from institutions, schools and programs to learners and learning." If we are to develop learner-centered models of education that help all young people take control of their intellectual and emotional faculties then it is necessary to have a solid grasp of how children actually learn.

We are able to learn, and help our young take responsibility for their learning, because as humans we have inherited remarkable brains. The essential purpose of the brain is to direct individual activity in ways that enable us to survive in an ever-changing environment. This is why we describe learning as "that reflective activity that enables the learner to draw upon previous experience to understand and evaluate the present, so as to shape future action and formulate new knowledge."

The graph on the cover preceding this section is the shoulder blade of an ox unearthed in the 1980s by archeologist investigating a Stone Age encampment in the south of France. Carbon dating showed this to be approximately 30,000 years old. The bone was marked with inscriptions that the archeologist couldn't decipher. It was clear the inscriptions were neither a tally, nor a pattern, nor any recognizable form of writing. Late one night one of the archeologist noticed the moon, and something in its shape caught his curiosity. Then it struck him. Here, on this fragment of a bone, was a lunar calendar complete with 72 observations...made something like 1600 generations ago.

One of our common ancestors (statistically all of us can claim a relationship to this thoughtful person) 30,000 years ago had the intellectual curiosity to watch the moon, night after night, and then transcribe these movements, at scale, onto the Stone Age equivalent of a back of an envelope, as he (or she) attempted to "think it through." The story of the Stone Age learner, however, gets even better when you imagine a small community of people (adults, adolescents, children on their laps) sitting around a campfire every night working out the meaning of the lunar phases together. Could this be the first example of adults teaching children how to learn?

Whether it is, or is not, will never be known, but the story captures the essence of learning and teaching. Teaching is the sharing of knowledge between the generations with the intention of this knowledge helping younger people take responsibility for themselves and the world around them. But it is even more than this. Good teaching enables young people to see how it is that older people actually learn and think. Good teaching helps children develop methods in which they can take new information and use it to create new knowledge and understandings for themselves. This form of teaching and learning probably has its roots as deep as is the history of human language.
CONSTRUCTIVISM

Within cognitive science, human learning is understood to occur through a process known as constructivism. As scientists study learning, they are realizing that a constructivist model reflects their best understandings of the brain's natural way of making sense of the world. Constructivist theories of learning are predicated on the progressive construction and deepening of meaning. The emphasis is on understanding as a process that is considerably more involved than transferred information.

Constructivists argue that, by definition, a child who is truly passive is incapable of learning. Such learning, by drawing on the full range of a learner's experience, strengthens the individual's ability both to find novel connections, and to harness peripheral perception. Most recently neurologists at the Salk Institute in San Diego argue that constructivist "learning is a dynamic interaction between a changing structured environment and neural mechanisms. The neural machinery is extensively shaped by activity stemming from the environment, while its intrinsic properties also constrain this modulation and play an indispensable role in shaping the resulting structures."

The constructivist brain is a self-organizing system that is shaped by its interaction with objects and events in the world. In adapting to events the brain's molecular mechanisms physically adjust to its environment. What this view argues is that perception is colored by experience. We neither see nor hear something in a totally subjective form, but rather our receptive processes are colored by those environmental stimuli that have captured our interest in the past. We actually build the structure of our brains as we use them.

Constructivism is open-ended, as is the neural structure of the brain. This does not mean, however, that students can be left to discover everything for themselves because real understanding means overcoming personally held naïve theories. The work of Howard Gardner at Harvard, and others, on the learning of very young children show their amazing capability to form "naïve theories of everything." Gardner capitalized on this understanding with the title of his most seminal work, The Unschooled Mind. In this he argued that within adults, be they university graduates or not, there was a "five year old unschooled mind struggling to break out." In other words, however sophisticated might have been subsequent explanations that might have been learned, in very many instances these were only shallowly acknowledged and did not replace those "common sense" theories that remain embedded from early childhood (like a ton of lead being heavier than a ton of feathers).

For true understanding to occur process and knowledge must be integrated in an effective partnership, and this requires an initial source of valued information (this is where the curriculum and the school comes in). The point coming through research into learning is that to develop effective models of learning we must seek a balance.

A balance between the political positions of progressive, experiential-learning (presumed to be on the political left, but good for creativity and collaborative skills) and disciplined, content-specific directed studies (presumed to be on the political right, and essential for basic skills.). The cognitive
scientist John Bruer sums up the research on learning this way: "Certainly the research implies that we can't ignore 'mere facts' in school instruction - domain knowledge is essential. But, conversely, curricula that merely transmit facts aren't desirable either. Cognitive research also implies that we have to be as concerned with how we teach as we are with what we teach." For example, "current social studies texts may present the facts about geography or history, but fail to teach course content so that students have an understanding of geography or history." Understanding is related to the ability to make valid connections between existing knowledge and experiences with that of new inputs. "In the most general sense, the contemporary view of learning is that [children] construct new knowledge and understanding based on what they already know and believe." Learning does not happen in a vacuum.

David Perkins of Harvard has observed that "understanding is a multi-layered thing. It has to do not just with particulars but with our whole mindset about a discipline or subject matter...If a pedagogy of understanding means anything, it means understanding the piece in the context of the whole and the whole as the mosaic of its pieces." Perkins says that understanding is not a state of possession but one of enablement. "When we understand something, we not only possess certain knowledge about it but are enabled to do certain things with that knowledge."

Constructivists see learning as a highly energetic, personally motivated, problem-solving activity which leads ineluctably toward understanding. Understanding requires a balance between knowledge and process. Lauren Resnick of the University of Pittsburgh Learning Research and Development Centre spoke for many cognitive scientists when she wrote: "First, we know that human memory for isolated facts is very limited. Knowledge is retained only when embedded in some organizing structure.

Thus, students who learn many separate facts are unlikely to retain their knowledge beyond the current period of test-taking - a much noticed, worrisome feature of the current educational system. Second, we now recognize that skills and knowledge are not independent of the contexts - mental, physical, and social - in which they are used. Instead, they are attuned to, even part of, the environments in which they are practiced. A new challenge for instruction is to develop ways of organizing learning that permit skills to be practiced in the environments in which they will be used (i.e., outside the classroom). Such contextualized practice is needed both to tune skills and knowledge to their environments of use and to provide motivation for practicing abilities that in isolation might seem purposeless or meaningless."

A Chinese philosopher captured the essence of what cognitive science is saying when he observed a couple of thousand years ago, "Tell me and I forget. Show me and I remember. Let me do and I understand." Successful learning and its application is too complex and multifaceted to be constrained within the walls of a school. In summarizing the research into the nature of human learning in the 1990s researchers working on behalf of the Santa Fe Institute, a multidisciplinary graduate research and teaching institute formed to nurture research on complex systems such as the brain, wrote: "The method people naturally employ to acquire knowledge is largely unsupported by traditional classroom practice. The human mind is better equipped to gather information about the world by operating within it than by reading about it, hearing lectures on it, or studying
abstract models of it."" They go on to observe, "Nearly everyone would agree that experience is the best teacher. What many fail to realize is that experience may well be the only teacher." It is not enough to just give children information, they need to work at making connections in the real world with the information they receive. This means appreciating the balance between in school learning and out of school activities.

Pause and consider the following questions
1) How can we achieve an appropriate balance between progressive experiential learning and disciplined, content-specific directed studies? What difficulties would we have to overcome to achieve this balance? Do secondary schools face different challenges from primary schools?
2) John Bruer writes we have to be as concerned about how we teach as we are with what we teach. Chris Woodhead, the former Chief Inspector of Schools in England, argued against this position on the basis it is simply more than teachers can do. Which view do you accept? What would it take to help teachers, governors, and politicians make the shift Bruer calls for?
3) How can we help children make valid connections between existing knowledge and experiences with new inputs? Do we value and take advantage of out-of-school experiences? If yes, how? If not, how can we do a better job?
4) A new challenge for teachers is to develop ways of organizing learning that permit skills to be practised in the environment in which they are actually used (outside the school). How can we meet this challenge?

Additional recommended readings

APPRENTICESHIP

Such comments on the limitations of schools may be hard for educators, politicians and others to accept, but they make more sense when one considers the way humans have traditionally shared knowledge and developed the talents of young people. The education of children has traditionally been associated not with the decontextualized setting of the classroom, but with the more integrated process of learning called apprenticeship. Apprenticeship learning put young learners into situations where they learned by doing. It was a form of learning that utilized their natural learning predispositions. Apprenticeship learning built functional skills through experimentation, explanation, and story construction. Apprenticeship teaching provided instruction reactively, in response to the learner’s action.
Remember, and this may sound harsh to some educators, much of schooling during the course of the 19th and 20th centuries was really little more than custodial care. Education was primarily about keeping children off the streets while their parents worked. Whatever learning teachers managed to encourage in their charges was a bonus, and reflected the dedication of the teacher more than the focus of the system. In contrast to the childminding of the Industrial Age learning through apprenticeship taught children rituals, how to grow crops, craft tools and weapons, and understand the phases of the moon. Children learned by being shown how, by doing, and then ultimately by taking responsibility for it by themselves.

Apprenticeship integrated learning, working, and living into a single seamless web. This form of community-based learning was as central to the health of the community as it was to the induction of young people into adulthood. Apprenticeship was far more than just skill acquisition. At its heart it was a process in which the young learned to take full responsibility for finding appropriate solutions to novel problems. This was possible for learners because they had earlier developed the ability to look at new problems from a variety of different perspectives. Apprentices aspired to become independent craftsmen, and a craft was more than a job, it was a way of life.

The artifact was a demonstration of their personality. It provided status in society, and the recognition of being significant within the community. In short, young apprentices saw that what they learned mattered and would actually be applied to situations that brought benefit to themselves and others. The lesson for the early 21st century is that a successful education should create in all young people a similar sense of ownership and pride in their practical and intellectual proclivities.

Apprenticeship describes a set of con-old processes that people with few resources to spare used to induct the next generation into the skills and values already practiced by adults. It assumed that children are inquisitive and, if initially fascinated by some mighty works, do not find it difficult to practice whatever subtasks are first needed. The Russian psychologist Vygotsky wrote on this in the 1920s when he described in academic terms what ordinary people had known of long before people started to theorize about learning and education. Such apprenticeship recognized four stages. The first stage of apprenticeship involves an older person modeling that subtask, so that the learner sees the significance of this to the final product. For example, a master artist showing a young apprentice how to properly prepare one's brushes and the paints on a palette. This subtask is done while the young apprentice is fully aware of the master's finished work, and in fact has as the ultimate goal mighty works of her own.

Apprenticeship progressively built new skills onto earlier basic skills, and took for granted that skills once learned and subsequently practiced were something that the individual learner would then assume full responsibility for themselves. Busy adults had only the time and energy to provide scaffolding, the second stage, for those tasks in which the learner was still uncertain. As the learner's confidence increased so the third stage - that of the "fading" of support - came into play, and the earlier scaffolding was progressively removed. The more proficient the learner became, the more they became independent of the teacher. Apprenticeship was based on the process of "weaning" young people of their dependence on the master. This, from a survival perspective, was key because young people were greatly needed in societies where being in your 30s and 40s was considered "old."
Throughout the apprenticeship there was a fourth stage, and it is what humans are incredibly good at doing - namely endless talking - "dialogue." In those cultures which it has been possible to study, such talking is only partly about the nature of what has to be done in the task, but is mainly about the circumstances and the culture in which the learning is being developed. It was intuitive, contextual learning that mattered. They applied what they learned as soon as they learned it. Learning had meaning because it was seen as a group activity where individual learners were indirectly teachers of their colleagues.

The English language has off-the-shelf expressions that describe this: "Jack of all trades and master of none" well describes the person who has only a rudimentary understanding and an incomplete set of skills. "Jack is as good as his master" was the ultimate compliment when Jack had completed a masterpiece to show that he was now out-performing his teacher.

FROM TRADITIONAL TO COGNITIVE APPRENTICESHIP: MAKING THINKING VISIBLE

As we have entered the knowledge age where learning how to learn matters for everyone, it is not surprising that since the 1980s cognitive scientists looking to establish what could be seen as the brain's natural learning strategies have extensively studied apprenticeship. It is through the study of apprenticeship that it is possible to formulate a theory of natural cognitive apprenticeship.

Lauren Resnick argues that if children are to become independent problem-solvers capable of understanding their own thinking and learning then ways must be found to integrate the lessons of traditional apprenticeship into how children are educated. She says: "I looked for elements common to successful programs that could point cumulatively toward a theory of how learning and thinking skills are acquired. I found three key features. First, most of the effective programs have features characteristic of out-of-school cognitive performances (cognitive apprenticeship). They involve socially shared intellectual work, and they are so organized around joint accomplishment of tasks, so that elements of the skills take on meaning in the context of the whole."\textsuperscript{13}

She continues, "Second, many of the programs have elements of apprenticeship. That is, they make usually hidden processes overt, and they encourage student observation and commentary. They also allow skill to build up bit by bit, yet permit participation even for the relatively unskilled, often as a result of the social sharing of tasks. Finally, the most successful programs are organized around particular bodies of knowledge and interpretation - subject matters, if you will - rather than general abilities."\textsuperscript{14}

According to the seminal work on cognitive apprenticeship by Allan Collins, John Seely Brown and Ann Holm there are three differences, however, between traditional apprenticeship and cognitive apprenticeship. In traditional apprenticeship, such as that of the aspiring artist above, the reasons for carrying out the subtasks are easily observable and understood. In cognitive apprenticeship, however, "one needs to deliberately bring the thinking to the surface, to make it visible, whether it's in reading, writing, problem solving. The teacher's thinking must be made visible to
the students and the student’s thinking must be made visible to the teacher. That is the most important difference between traditional apprenticeship and cognitive apprenticeship.” This process of making thinking visible is known as metacognition. One can think of metacognitive skills as the ability to be critical of one’s own problem solving.

The second difference between traditional apprenticeship and cognitive apprenticeship is in the fact that traditional apprentices see how what they are learning is situated in the real world - the young artist sees the mighty work and wants to create it for herself. In this case apprentices naturally understand the reasons for undertaking the process of apprenticeship. “But in school, teachers are working with a curriculum centered around reading, writing, science, math, history, etc. that is, in large part, divorced from what students and most adults do in their lives. In cognitive apprenticeship, then, the challenge is to situate the abstract tasks of the school curriculum in contexts that make sense to the students.”

The third difference between traditional apprenticeship and cognitive apprenticeship is the issue of transfer. In traditional apprenticeship it is obvious how the subtask learned, preparing the paints, transfers over to the actual production of a masterpiece. However, it is not obvious to young learners how what they learn in history class, for example, transfers into their understanding of the real world. Transfer simply means applying existing knowledge in a setting sufficiently novel that it also requires learning new knowledge.

Cognitive apprenticeship actively seeks to make thinking visible so that younger can see how what they learn in the classroom is actually applied to activities in the real world. This is where interaction with the community in the form of internships and the like becomes so important. This is also where the effective use of information and communication technologies can come into play. For example, a high school research project in the state of Illinois on the study of artificial intelligence can be shared on the school’s web site in order to receive feedback and criticism from students and scientists in other parts of the world. In this way young people feel responsible for generating knowledge that actually influences others.

Cognitive apprenticeship has shown to be an effective model of learning because it makes the processes of the activity visible to the learner. It is a process of nurture that has been practiced for so long that it appears to have influenced our natural processes. The apprentice learns by applying their knowledge in an activity that matters to them and the group they feel a member of. The Institute for Research into Learning in Palo Alto California notes that “what motivates people is their innate desire to belong. People are automatically motivated to learn whatever they need to become a member of the community to which they want to belong.”

There is, however, a real conflict between what motivates learning and many of our institutional arrangements for it. The Swiss researcher Etienne Wenger captures this paradox when he writes, “Our institutions are largely based on the assumption that learning is an individual process, that it has a beginning and an end, that it is best separated from the rest of our activities, and that teaching is required for learning to occur. So we arrange classrooms where students - free from all the distractions of their participation in the world - can pay attention to a teacher or focus on exercis-
es. We design computer-based training programs that walk students through individualized sessions covering reams of information and drill practice." Not surprisingly, Wenger continues, "The result is that much of our institutionalized teaching and training is perceived by would-be learners as irrelevant and most of us come out of this treatment feeling that learning is boring, arduous, and that we are not really cut out for it."

Pause and consider the following questions
1) What might we learn from the cognitive apprenticeship model of learning?
2) How could we use understandings about cognitive apprenticeship to improve current educational structures?
3) What would need to change to take maximum advantage of this approach to learning?

Additional recommended readings

FROM SPECIALIZATION TO EXPERTISE

A primary reason why it has been so difficult for teaching and training to move towards models of learning that are seen by most young people as being relevant to their real-lives is the over-emphasis placed on the development of specialists by formal systems of education. Specialists do not need to see the big picture, they just have to understand their individual part. We have inherited this emphasis on the cult of the specialists from the economic needs of the Industrial Age, and the epistemology of reductionism. Even today, with our infatuation for an easily understandable world of sub-components, we live comfortably with self-contained specializations, and the importance of specialists - people who know just everything there is to know about probably an ever smaller and more self-contained area of study.

Our advanced standard of living is the direct result of specialized inquiry into a multiplicity of topics resulting in new products, new medicines, new technologies, and new understandings in everything from astronomy through to zoology. "Advanced" levels of schooling are the first, almost remorseless step, in a young person's gravitation to becoming a specialist. Yet as a society we are fast coming to recognize that overspecialization also creates real social problems. We sense that the single mindedness of specialists has become a root cause of our disconnected, fragmented way of life. Such problems come under the rubric of unintended consequences. Who would have thought isolating children's learning in a classroom would actually turn a lot of children off to learning? What is good for the specialist may not be good in all its aspects for the wellbeing of society, or the learning needs of children. Remember, humans learn by making connections, and no child in the western world spends more than 20 percent of their waking hours in a classroom.
Work in the 1990s by two Canadian cognitive scientists, Bereiter and Scardamalia, on specialization and expertise is especially helpful in understanding the subtle and highly significant difference between those concepts that, for many of us, are frequently assumed to be the same thing. We have to understand these differences if education in the 21st century is to balance the need for the development of basic skills with the need to also develop the higher order thinking skills of creativity and collaboration.

A specialist, by working within the well-defined parameters of a specialism 'knows the subject from the top to the bottom.' Specialists know all the rules, all the tests, and all the possible combinations and formulae. Their authority rests on the depth of their knowledge, and the understanding of the rules and is uncluttered by the need to assess extraneous influences. Such a person exudes a confidence in their competence - in some, this comes through as arrogance. No one can better them. Discussion with such people is often difficult. Just where their specialisms fit in a bigger picture does not trouble such a person, for that is essentially unquantifiable, imprecise and highly uncertain; there are no rules for that kind of thing, so these are questions best left unanswered.

A caricature perhaps, but the world has come - quite rightly - to be fearful of specialists for, in some hard-to-define way, we sense they are just not real. They break the work down into bits, and that gets us, both individually and collectively, into trouble and makes us schizophrenic. Such thinking is well-exemplified by the comments of a leading American researcher who asked, "why do you want to use an evolutionary framework to understand the science of learning?" "We have a science of learning and it is not necessary to get into the nasty conflicts revolving around evolution. What you're doing," he continued, "only makes the issue more difficult for people to accept." Contrast this comment with those of the cognitive neuroscientist Michael Gazzaniga who observed, "If the evolutionary perspective is simply set aside, the data collected by psychologists and neuroscientists are likely to be grossly misinterpreted." 20

Neurobiology gives us powerful snapshots of the brain as it operates in the current generation, but it does not tell us how we got here. Cognitive science delves into matters of learning that, so far, neurobiology can not explain. But, both are about how the brain works now. Neither says anything about why our present brains are structured as they are, and neither deal very well with the issue of predispositions. For example, children do not learn the complexities of language from scratch, they have a "language instinct." More on this later, but to understand the workings of the brain and the complexities of learning we argue an evolutionary perspective provides a critical framework in this effort.

Experts, argue Bereiter and Scardamalia possess certain additional qualities that make them very special people. Experts start off as specialists. They know an awful lot about their own subjects; you can't fault them on detail, any more than you can fault a specialist, but they have one vital attribute - they're able to 'get outside themselves and their subjects' and look at their specialization from a distance. They are essentially quizzical. They ask themselves uncomfortable questions about their specialization's significance, and its possible relevance. In a sense they know so much about their subject that their natural curiosity makes them inquisitive about many other things. They are quick to grasp the overall situation, rather than just dealing with single parts; big issues fascinate them.
The Italian geneticist Luigi Luca Cavalli-Sforza captured the essence of how an expert thinks in the introduction to his book *Genes, Peoples, and Languages* when he wrote:

“This book surveys the research on human evolution from the many different fields of study that contribute to our knowledge. It is a history of the last hundred thousand years, relying on archeology, genetics, and linguistics. Happily, these three disciplines are now generating many new data and insights. All of them can be expected to converge toward a common story, and behind them must lie a single history. Singly, each approach has many lacunae, but hopefully their synthesis can help fill the gaps. Other sciences - cultural anthropology, demography, economy, ecology, sociology - are joining in the effort, and are justly becoming pillars of interpretation.”

Cavalli-Sforza describes the problems the synthetic approach of the expert encounters when he noted:

“It would be impossible to communicate the conclusions about human history and the causes of human evolution if one had to rely on the jargons of such diverse disciplines. Scientific terminology insures precision and increases the speed of communication among specialists, but it creates a barrier between them and the general public.” He continues, “To some, history (including evolution) is not a science, because its results cannot be replicated and thus cannot be tested by the experimental method. But studying the same phenomenon from many different angles, from many disciplines, each of which supplies independent facts, has the value of largely independent repetition. This makes the multidisciplinary approach indispensable.”

Bereiter and Scardamalia explained this in their own way,

Experts, we propose, tackle problems that increase their expertise, whereas (specialists) tend to tackle problems for which they do not have to extend themselves (by going beyond the rules and formulae they accept). Experts indulge in progressive problem solving, that is they continually reformulate a problem at an ever-higher level as they achieve at lower levels, and uncover more of the nature of the issue. They become totally immersed in their work, and increase the complexity of the activity by developing new skills and taking on new challenges.”

The evolutionary biologist Ernst Mayr puts it even more succinctly when talking about the biologist’s search for synthesis, “Being a biologist does not mean having a job; it means choosing a way of life...They never lose the excitement of scientific discovery, nor the love of chasing after new ideas, new insights, new organisms. And so much in biology has a direct bearing on one’s own circumstances and personal values.”

Experts with such high level ‘open thinking’ are vastly important people in a culture that is changing so rapidly that it is hard to see where we are headed. Unlike the specialist’s supreme confidence within a specialism (not much use when the walls of the specialism are falling apart!), the expert is essentially humble and questioning, more aware of what he doesn’t yet know rather than what is
already known. Experts of course know the rules, but they also know how to reformulate them, even when to break them so as to fit new circumstances. They are persistent, industrious and always curious. They are always searching for the perfection that is always just out of their reach. “Let’s back up on this problem. Think this one through again. See it from another perspective; imagine it in another way. Give ourselves a breather, and ask somebody else what they think.” These are the words of the true expert.

The creation of conditions in which expertise can develop needs both the practices of constructivist learning, and the rigors of subject-specific disciplines. It is in the study of expertise that we find the clues we need for developing models of learning that actively promote creativity, metacognition and transferability. Expertise is a frame of mind that starts forming in the nursery, and begins to mature in the primary school. While specialization has become a feature of modern society, it is not, however, particularly natural to the human brain that has evolved over the millennia to be a multi-faceted, multi-tasked organism that is predisposed to think about any piece of data, or idea, from very many perspectives. It works in terms of wholes and parts simultaneously. The glory of human learning is that it is essentially a complex, messy, non-linear process.

INTELLIGENCE AND ITS DEVELOPMENT

Much of what the 21st Century Learning Initiative recommends is predicated on a better understanding of human learning and how to optimize the potential of the human brain. The brain can, literally, do almost anything, but in its own way. Yet, wonderful as the brain is, it is also amazingly stubborn if coerced to operate in a fashion that runs counter to its natural predispositions. Michael Gazzaniga goes further when he warns that, “all the ways that human societies try to change minds and to change how humans truly interact with the environment are doomed to fail. Indeed, societies fail when they preach at their populations. They tend to succeed when they allow each individual to discover what millions of years of evolution have already bestowed upon mind and body.”

Work over the past 20 years by researchers into the nature of human intelligence has revolutionized the way we understand such innate abilities (refer to attached articles). In 1984 Gardner postulated the concept of multiple intelligences. Initially he identified seven forms of intelligence, each one of which could be separately identified, and measurements suggested that none of them was directly correlated to any other. These different intelligences enable each person to find their way around the world in different ways - linguistically, numerically, spatially, kinesthetically, musically, and in terms of interpersonal skills as well as intra-personal skills. With this analysis, researchers have become fascinated in trying to understand the mechanisms by which each child inherits a unique profile of these varying skills. (Why is it that one child is like a poet, another like a mechanic and another apparently nothing, even when their home culture appears identical?) Gardner’s work argues that to reduce all forms of intelligence to a single quotient is largely meaningless.

David Perkins’ work on the “learnability of intelligence” makes a distinction between the genetic base of intelligence, and those forms of intelligence based on content specific skills (i.e. what makes a good car mechanic or a heart surgeon), as well as that form of intelligence that is based on
reflection and a quizzical approach characterized by the nature of expertise." Perkins argues that "most young people operate well below their natural level of intelligence, and if this could be raised by 20 percent the results would be a very different world indeed." He has identified three components to intelligence: the fixed neurological intelligence linked to IQ tests; the specialized knowledge and experience that individuals acquire over time; and reflective intelligence, the ability to become aware of one's mental habits, and transcend limited patterns of thinking.

Although all these forms of intelligence function simultaneously, it is reflective intelligence, Perkins says, that affords the best opportunity to amplify human intellect. This is the kind of intelligence that can be taught, and it helps people make wise personal decisions, solve challenging technical problems, find creative ideas, and learn complex topics in different areas. Perkins noted in 1992, however, that "hardly anything in the conventional education practice promotes, in a direct and straightforward way, thoughtfulness and the use of strategies to guide thinking. Those students who acquire reflective intelligence build it on their own, by working at personal repertoires of strategies. Or they pick it up from the home environment, where some parents more than others model good reasoning in dinner table conversations, press their children to think our decisions, emphasize the importance of a systemic approach to school work and so on."

Since the early 1990s there has been pioneering work on emotional intelligence which was first lucidly described by Joseph LeDoux, Antonio Demasio and Daniel Goleman (refer to attached article). The key point emerging from this work is that learning is driven as much, if not more, by emotions as it is by intellect. The link between the emotions and intrinsic motivation should surprise no one; consequently the sterility of emotionally drained and aesthetically neutered learning environments has to be understood as contributing to low learning achievement.

In early 2000 the Oxford scientists Danah Zohar and Ian Marshall argued for a concept of spiritual intelligence. As noted at the beginning of this section, the 30,000 year old bone with the inscriptions of the moon revealed humans to be an inquisitive species. Throughout our history we have been pondering eternal questions about the meaning of life, our place in the universe, the nature of God and ultimate purpose. The search for a better understanding of such fundamental questions has led to some of the greatest works of art, literature, music and architecture and is the essence of philosophy and the sciences. Every civilization has channeled the spiritual search for ultimate meaning into some form of religious observation - and not always with benign results.

Studying this phenomenon Zohar and Marshall have reached what to many is a most obvious conclusion - a developed sense of spiritual intelligence is an evolutionary advantage. Those who have it are better able to keep going in conditions when others might simply give up. This sense of purpose gives a heightened intrinsic motivation, and a reason for living. Despite our technologically advanced societies, people in the 21st century still seem to be aware that there is some form of spiritual dimension to life that is not accounted for by our current understandings of the mind, or of intelligence. Human beings, it seems, are essentially spiritual creatures because we are driven by the need to ask fundamental or ultimate questions.

The Nobel Prize winning economist Robert Fogel, argues that the battle over equality in the 21st
century will not be over material issues, but over spiritual issues. He writes, “The quality of choices and the range of opportunity depend critically on how well endowed an individual is with spiritual resources. The quest for spiritual equity thus turns not so much on money as on access to spiritual assets, most of which are transferred and developed privately rather than through the market. Moreover, some of the most critical spiritual assets, such as a sense of purpose, self-esteem, a sense of discipline, a vision of opportunity, and a thirst for knowledge, are transferred at a very young age. The reforms required to achieve spiritual equity overlap with, but are not identical to, those required to achieve material equity. Shaping a new, broader program of equalitarian reforms, while continuing to pursue the unrealized objectives of the program for material equity will not be easy.”

WHAT MOTIVATES LEARNING?

Learning is driven by a search for meaning and purpose. If the purpose of education is to help all students take control of their own learning and develop their creative skills then we need to look carefully at what motivates learning. For example, there are many definitions for creativity but in the literature from psychology and cognitive science there is one concept that is in almost every effort to define how people develop it - intrinsic motivation. According to their review of the research on creativity the American psychologists Hennessey and Amabile observed that, "People will be most creative when they feel motivated primarily by the interest, enjoyment, satisfaction, and the challenge of the work itself - not by external pressures." No one has ever enjoyed science as much as Einstein.

The Washington Post carried some anecdotal evidence about how schools do little to help students develop their intrinsic motivation to make sense, and subsequently short-change the development of creativity. "Enter just about any elementary or middle school," it reported, "and you'll find that for doing well, students constantly are rewarded with stuff: McDonald's fries for good grades, pencils if they show up for standardized tests, a chance for a restaurant lunch if they do a good deed." The reason The Post gave for relying on extrinsic rewards was "educators rely on such incentives at a time when studies show it is harder than ever to motivate students. There is no fix on why teachers are grasping at ways to engage children, but commonly cited culprits include busy parents who don't demand much or don't pay attention, more family and societal problems, rife consumerism and scanty Nintendo-era attention spans."

Teachers are doing what they can to make learning happen in their classrooms, and central to creativity is a base of knowledge on which children can build new ideas and connections. Good schools and teachers help children acquire such knowledge. But for children to develop creativity and a passion for excellence there are yet other factors that must come into play. These are persistence, commitment and a sense of purpose. Remember, it is purpose (meaning) that drives all human activity, including that of learning. The most creative and successful people in any endeavor seem to get extremely involved in a problem. They become so immersed that they stick to the problem, and the problem sticks to them. This sort of dedication comes from an internal desire to succeed. It is the result of intrinsic motivation.
Yet, increasingly even educators in good schools see the need to use external rewards and punishments to try and develop a desire within children to learn and take control of their own mental faculties. On both sides of the Atlantic teachers make the point that there just isn’t time for children to explore what they are good at because the curricula must be covered. Howard Gardner noted in 1993, that “the greatest enemy of understanding is coverage. As long as you are determined to cover everything, you actually ensure that most kids are not going to understand. You’ve got to take enough time to get kids deeply involved in something so they can think about it in lots of different ways, and apply it - not just at schools, but at home and on the street and so on.”

Consider Gardner’s comments in light of the following: “The Third International Mathematics and Science Survey (TIMMS) criticized curricula that were ‘a mile wide and an inch deep’ and argued that this is much more of a problem in America than in most other countries. Research on expertise suggests that a superficial coverage of many topics in the domain may be a poor way to help students develop the competencies that will prepare them for future learning and work.”

The significance of these comments is to be found in the fact that the brain is predisposed to learn and take responsibility for it, yet we’ve created a culture that is apparently for many antithetical to learning. In response educators use extrinsic rewards to bribe children to learn, and the fear of failing standardized tests as the stick to punish those who have become completely turned off to education, and indeed for far too many much of life generally.

The motivator of much student achievement is the vision of a good job and a decent income. According to Geoffrey Colvin of Fortune Magazine, “financial incentives will get people to do more of what they are doing. Not better, just more... If you want to speed up the assembly line and you’re not too particular about quality, workers will speed it up for a financial incentive. That’s what the evidence shows... But this is exactly what employers today don’t want. If they want to speed up the assembly line, they rewrite the software. From employees they want imaginative thinking about how to solve problems that didn’t exist yesterday (e.g. those problems you can’t be taught to deal with beforehand). Can you get this kind of thinking by offering to pay for it? What would you guess? You’re right, of course. Trying to pay for it doesn’t necessarily do it. The evidence on this is so overwhelming that it’s amazing anyone thinks otherwise, but plenty of people do.”

If we want students to work smarter, more creatively, and with more purpose it will take more than material rewards and punishments. This is a staggering thought, but one that seriously needs to be addressed. We must muster the courage to ask ourselves, “Education for what?”

CONCLUSION

Those who do not want to get deep into the the science of learning feel comfortable blaming stagnant levels of academic achievement on teachers and school administrators going soft, or being under the spell of “progressive ideas about learning.” Supporters of this view suggest the difficulties children face in learning have nothing to do with the fact that communities are not really sure
what they want education to be all about, or what the appropriate role of professionals and the rest of us should be. For many, this may be a useful position to hold, but we argue it is one that is potentially dangerous.

We argue that those responsible for the future welfare of children need to go deeper to understand "the crisis in education." At a profound level, state-sponsored systems of education are stuck with trying to come to terms with balancing tolerance without sliding into a world where all issues are seen as being relative. The distinguished European political philosopher Nikolaus Lobkowicz has observed that, "We live in societies with conflicting ideas on almost everything, from the most basic truths to the element of moral behavior. And, contrary to past societies, we seem to be able to bear it by insisting on tolerance and educating our offspring to accept this attitude ... Yet, tolerance ceases to be a virtue, indeed is in danger of becoming a vice, if it amounts to not caring for truth, ignoring what is morally good or not appreciating the values of the community. In order not to be accused of intolerance, people often refrain from being truly convinced of anything. In this way, the culture of tolerance characteristic of societies which take democracy seriously is in danger of turning into a culture of 'anything goes'...In other words, the problem we face is how to be tolerant without succumbing to relativism."

During the second half of the 20th century the debate around education has revolved almost exclusively around economic issues. The phraseology is familiar to all of us, "what you earn is related to how much you learn," quipped President Clinton in the late 1990s. The mantra pounded into children is go to school and learn because you can then make lots of money. We are not opposed to people making money, but from the perspective of human learning we need to appreciate the fact that many children need more to trigger their desire to learn than deferred promises of the good life. We have been learning as long as we have been a species because we care about deep issues. As anyone who has spent time with teenagers, or remember their own youth, they spend endless hours talking through the night about why we are here and what is my purpose. This means education must find a purpose that inspires and requires all young people to take responsibility for their God-given talents and skills. This requires dialogue, which is what the 21st Century Learning Initiative is dedicated to starting.

We have few answers, but hopefully enough questions to get you and future participants of our courses started on a path towards more human centered models of learning. For in the end, you can not force a person to learn. You can coerce them to show superficial understanding of information and concepts on tests, but in the final analysis each individual is in charge of their own learning, and they will decide whether or not they want to work at it.

Pause and consider the following questions
1) How can we create the conditions necessary for the development of expertise? What would it mean for the curriculum, for teachers and for pupils?
2) What do our current understandings of intelligence tell us about children's learning?
3) "If we want young people who are personally responsible for their own learning, who work creatively, and with purpose it will take more than external rewards and punishments." Do you agree?
Additional recommended readings


REFER TO ENDNOTES FOR ADDITIONAL READINGS:

9) Ibid., p. 77.
12) Ibid., 181.
14) Ibid.
16) Ibid., p. 10.
19) Ibid.
22) Ibid., p. VIII.
24) Ernst Mayr. This is Biology. (Cambridge, MA: Harvard University Press), 1997, p. 44.
28) This comment was made by David Perkins at a conference sponsored by the 21st century Learning Initiative at Wingspread. (Racine, WI: 1996).


