Appendix 1A - Empowerment through More Effective Learning[1]

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Introduction

Brain Operation as a Predictive Process

Fostering Empowerment through Effective Learning

[1] This essay was written to serve as an appendix to the chapter titled "Restoring Your Rights in American Democracy: Empowerment through Critical Thinking." That chapter is the opening chapter of the second book in the treatise titled *American Democracy Endangered*. The second book (*A Sense of Place in Perspective*) that book to of the trilogy, *American Democracy Endangered*, speaks to the role of the electorate in protecting its rights in American democracy. It is included as an appendix in this first book of the trilogy as a segue to BOOK TWO.

Empowerment through More Effective Learning

Introduction

The Relevance of This Essay

Disenchantment by Many Americans

Many Americans are greatly disenchanted with conditions that have emerged in the last few decades. One such condition is that distribution of income has been sharply skewed to the right, leaving a great many Americans who work full-time with incomes insufficient to pay for proper medical care. Some can't even afford adequate food or housing without the resort to use of food stamps or housing subsidies funded by federal programs.

Among the unalienable rights implied in the Declaration of Independence is an equality of the right to reciprocity, meaning a fair share of the societal production.

Obtaining that fair share of societal production requires an equitable structure of the political-economic system. The concentration of wealth has facilitated the concentration of power so that another element of the equality of rights implied in the Declaration of Independence has been significantly violated. That equality of rights is one of equal access to the tools of government. The denial of some of those rights is currently being challenged in the courts on the basis of gerrymandering of voting jurisdictions. That is not the only issue in the denial of the quality of rights for representation in government.

Eligible Voters Who Want to Protect Their Rights

Eligible voters, who want to protect their aforementioned rights, and their other rights and interests, need to enhance and exercise power. A significant road to empowerment is education. Unfortunately, public education has not been doing very well for the masses. And, when it comes to higher education, the costs have skyrocketed and the results are not commensurate with the expenditures. As a result, student debt has reached a shameful level, and not even the laws of bankruptcy are available for such debt.

The Way the Brain Works

This essay is part of a larger project to empower the populace to reach a more effective learning process. The particular focus of this essay is on how the brain works in processing information obtained by human beings through their various senses and on what is known about how to make the learning process more effective. This essay is oriented to understanding the learning process in the individual brain. It is a step towards the learning process of the community that is composed of a collection of brains, albeit with different abilities for learning and different strengths in the network of people making collective decisions.

The Conventional Wisdom of the 20th Century. The conventional wisdom of the 20th century was that indoctrination by transmittal of information would lead the learner to simply assemble the facts into a structure that represented what was envisioned as reality. Not only is a great deal of the reality poorly understood, but now it is becoming apparent that the process itself is poorly understood.

Advancement in the Understanding of the Brain at Work. Advancement in the understanding of how the mind, as the brain at work, actually works is explained in a recent book by Andy Clark. Our short portrayal of the learning process drawn from his *Surfing Uncertainty*: *Prediction, Action, and the Embodied Mind* is as follows:

> Individuals approach a situation with a view as to what would be sensed through the incoming stimulus flow. Rather than simply building a picture of reality by adding the incoming information to the vast reservoir of information in the brain, they start with a vision of what is expected. If the next stimulus input does not match their expectation, it may be revised to an expectation that more closely matches reality. Several mental structures or processes, such as attention, memory, schemata, needs, and cultural prescriptions, contribute to the self-organization of a modified expectation. The changed expectation adds to or updates the information in memory. Action follows based on the revised expectation, resulting in behavior that is more adaptive and to changes in the next stimulus input. This learning cycle or process is reiterated in the next occurrence of the situation. (See page 52of *Surfing Uncertainty* for Clark's extended summary of the predictive learning process).

The process makes predictions concerning not just how the stimulus input should evolve (if the world is indeed as expected) but also what incoming stimuli should be actively solicited and given the greatest weight as processing unfolds.

Clark wrote that "This [the hints of the meaning of understanding the world as encountered through perception] will be an understanding in which experience, expectation, estimated uncertainty, and action are inextricably intertwined, together delivering a grip upon --- and a trajectory within --- a world whose organism-salient features are continuously disclosed (and in some cases, continuously created) as a result of our own activity. The fit between mind and world, if this is correct, is a fit forged not by some form of passive 'apt description' but by action itself: action that continuously selects the stimuli to which we respond." (See page297 in *Surfing Uncertainty* and especially the endnote cited.)

This new theory, called *Predictive Processing,* integrates into one framework much earlier work on mind, body, and world (extended and embodied mind), as well as on cognition, learning and action (cognitive psychology).

It is the vision of what is expected that is critical to how close to reality the blending of the inputs with existing knowledge actually comes to in behavior. If the envisioned expectation is so far from reality that the learner is unable to effectively adjust the perception, little progress is made. The learner may seek out additional or revised inputs to aid adjusting her expectation in the situation. The learner may also only pay attention to stimuli that fit the expectation, thus confirming an expectation that is not fully adaptive.

Empowering the populace to reach a more effective learning process engenders not only development of progress in individual learning, but also learning in the collective mind.

The Learning Process in Perspective

Learning is a Subset of Thinking

We start our discussion of the learning process with the point that learning is an integral component part of the overall thinking process of human beings who are complex adaptive organic systems interacting with resources of mind, body and environment. The basic mechanism and immediate outcome of learning is ongoing additions to and updating of memory which expands the potential for effective action. In this essay, we will place this basic learning mechanism in its broader context of thinking and predictive processing.

Bedrock processes of predictive learning slowly instill mental structures, such as models, frameworks, strategies, and routines, which consist of probabilities and hypotheses about physical and temporal aspects of reality, coded as patterns of neural connectivity built and re-built as experience unfolds. Structured probabilistic know-how gained by hierarchical prediction-driven learning enables us to see beyond surface statistics to the deep-structure of interacting distal causes(See *Surfing Uncertainty*, pages 270-271 and 171-172 on structured probabilistic learning).

Thinking is Beyond the Brain

A relatively new perspective gaining increased interest in Cognitive Science and related fields is extended and embodied cognition. Andy Clark, in his *Supersizing the Mind*, wonderfully describes myriad ways in which the mind relies on the inner world (embodied cognition) and the outside world (extended cognition). Information about our bodies and the environment is incorporated into our thinking. For instance, the use of a written list and internal feelings that are reliably available when needed may become part of our thinking process. Mechanisms of the cognizing mind, such as decision-making, reasoning and the use of language are not all in the head.

Effective Ways of Learning

Ulrich Boser has recently described in his *Learning Better* an effective three-stage learning process. The process in short is as follows: At first you tinker and explore to get a sense of what exactly you need to know. In the next stage, the topic has become of value and meaningful to you and you proceed to explore it in depth. When you have given enough attention to the topic, you will shift to a third stage where you bring into your process different interpretations and ideas from other fields and pursuits. [See page 14].

He has also compiled a comprehensive description of ways to learn better, to be a more effective learner, in the form of learning strategies. The ways in short are: (1) Make learning a topic of value, meaningful and significant to you; for instance, use active learning methods such as explaining ideas encountered to oneself or others. (2) Early in learning, generally explore the topic employing rigorous information management; as an example, have short-term goals and benchmarks. (3) Later, set aside time to practice retrieving your knowledge to gain some mastery. (4) Get feedback about outcomes with hints for improving them. (5) Seek to apply your knowledge to gain understanding of the underlying system of the relevant domain of ideas.

Understanding the more fundamental principles and underlying structure of a topic gives a learner not only a specific thing, but a model for understanding things like it that she may encounter. She has gained a basis for recognizing subsequent phenomena as special cases of the idea originally mastered and can thereby use the acquired knowledge in her thinking and behavior beyond the situation in which the learning has occurred.[See page 113.]

As we move on to an evolutionary perspective, note that games children play in America today contrast sharply with games played by primitive societies in eras long gone. Consider what Jared Diamond wrote in his book *The World until Yesterday: What Can We Learn from Traditional Societies?* Using a New Guinea Highland Village as an example of traditional societies of an ancient era, he notes that in those societies "... Networks of societal relationships tend to be more important and lasting that in Western state societies [p. 90]." After discussing some consequences in those cultures, on the next page he writes the following:

> "The flipside of that overriding emphasis on social networks in traditional societies is our greater emphasis on the individual in modern state societies, especially the United States. We not only permit, we actually encourage, individuals to advance themselves, to win, and to gain advantage at the expense of others. In many of our business transactions we aim to maximize our own profit, and never mind the feelings of the persons on the other side of the table on whom we have succeeded in inflicting a loss. Even children's games in the U.S. commonly are contests of winning and losing. That is and so in traditional New Guinea society, where children play involves cooperation rather than winning and losing."

Later in the same book, in a section titled "Child play and education" he describes what an anthropologist observed noting how children's games are educational in that "… educational play of children imitates everything that goes on in the world of Dani[the people observed by anthropologist Karl Heider] adults, except rituals reserved for adults [page 203]."

An Evolutionary Perspective

"Human beings are not wicked by nature … The problem holding everything up thus far is that *Homo sapiens* … is an innately dysfunctional species. We are hampered by the Paleolithic Curse: genetic adaptations that worked very well for millions of years of hunter-gather for existence but are increasingly a hindrance in a global … urban and technoscientific society."Sowrote Edward O. Wilson in his *The Meaning of Human Existence*[page 176].

This quotation is relevant because a great deal of the dissatisfaction of conditions in American Democracy. It is because we have not done well in balancing individual and community interests. Essentially, ***the way our genes and memes have developed leaves us short of making good predictions of outcomes from the way we behave as individuals and as a society.***

We can by learning as individuals and as a society improve the outcomes that we will experience in the future of American Democracy. This perspective can be better understood by consideration of Wilson's latest book, *The Meaning of Human Existence*, especially his last chapter,*Alone and Free in the Universe*. For instance, in it he discusses our freedom in choosing goals.

This Essay is Part of a Larger Project

Although this essay is focused on the individual mind, here are few exploratory comments on the collective mind. Individuals interact with other individuals forming networks. The individuals as nodes in the networks have different qualities of knowledge, different numbers of contacts, and different strengths of impact. As a result of the interaction, emergent properties evolve having produced a collective mind.

A planned follow-on essay is to be focused on enhancing the collective mind. That refers to the emergent properties that evolve as individuals improve their understanding of reality and interact with

others in group action. The scale of group action ranges from small networks in the form of organizations, and even informal groups, on to the national political-economy, especially including the national government as it provides structure and process for its evolution.

This discussion was started as the third essay of three essays serving as appendices to an online book titled A *Sense of Place in Perspective*. That book is background for the second volume of a series already published on the web as part of the Academy in the Cloud Enterprise (ACE). The second volume is titled *American Democracy: The Declaration, Pursuit and Endangerment.*

Brain Operation as a Predictive Process

The Proactive Nature of Brains Provides Expectations

Human interaction with the world is a dynamic endeavor. Each of us attends to and processes streams of sensory stimulation, and intends and initiates motor actions, which in turn guide the further production and selection of sensory information. Clark points out that, as these cycles or sensorimotor loops unfold; there are active self-structuring of information flows via the generation of internal models, concepts and routines that are tested by self-generated actions. These structures serve as the primary basis for expectations about the next stimulus array.

Rather than assembling a representation of what is in the outside world, the brain is massively and constantly engaged in matching actual sensory signals received with predicted signals, trying to have its expected world more closely correspond with the actual local world that produced those sensory signals. Sensed deviations from predicted sensory states lead to the self-organization of revised expectations and new or revised hypothesized knowledge in memory. We surf waves of sensory stimulation and draw on prior learned memory for inputs to that self-organization process. The overall learning process is a combination of sensing, thinking, experience and memory.

Statistical Hierarchical Predictive Learning

Newly encountered environmental situations provide an incoming stimulus stream that is at least to some extent unexpected. An objective that has evolved is for our brain processes, body actions, and environmental resources, working together, to continuously disclose or create salient features as a result of our own activity in a world structured, in large part, by the affordances for action that it presents. Sensed mismatches inform us of what is salient and "newsworthy" (surprising and relevant) within the dense sensory array. Expectations about new situations, initially based on prior knowledge, will most likely have unexpected features, and thereby will require revision.

The brain employs a learning strategy known as *Empirical Bayes* to acquire its own prior knowledge from the sensory input as learning proceeds. The layers of the brain's multilayer hierarchical structure are inter-animated, each layer attempts to account for the patterns of activation (probability distributions) at the level next below, tuned by the incoming sensory signals, allowing the system to acquire its own prior knowledge from the sensory inputs as statistical-predictive learning proceeds.

By combining the use of multilayer predictive models with powerful forms of statistical learning, we can infer the high-level structure specific to a domain and even the high-level structures governing multiple domains by exposing an apt multilevel system to raw data. Suitably scaffolded by this structure of large-scale expectations, learning about more detailed regularities becomes possible.

Clark tells us that what seems to emerge are structured are productive bodies of knowledge that are nonetheless acquired on the basis of multistage predictive learning driven by statistical regularities visible in the raw data. Early learning here induces overarching expectations (e.g., very broad expectations concerning what kind of things matter most for successful categorization within a given domain). Such broad expectations then constrain later learning, reducing the hypothesis space and enabling effective learning of specific cases. Systems have learned, for example, about the so-called *shape bias*. Expectations according to shape bias are that observed items will tend to fall into the same object category based upon shapes; since categories of objects such as cranes, balls and toasters tend to contain objects the same shape.

Contextual Effects in Early Processing

There are multiple context effects that broadly constrain and channel the flow of information about the stimulus array. Some effects are automatic; others are in our awareness and subject to our control and devising. Working together, these contextual effects initially structure input information so that there is efficient focusing on relevant detail in ongoing information processing and faster adaptive success.

In perception, there is a kind of recurrently negotiated gist, where we first identify the general scene followed by the details. This gets the predictive brain into the right general ballpark. Incoming data provide a rich set of sensory cues that we have come to expect in various kinds of situations; these cues and what they signify are available to guide relevant actions.

Brains are deeply informed by the basic facts about our embodiment, such as our size, the placement of our sense organs, the reach of our limbs, and so on. There are internal cues about effects of our own bodily motion upon sensory inputs. Known elements in familiar stimulus arrays facilitate the brain's information processing. Attention processes and heuristics act to select frugal action-based routines. The proactive, restless brain's activities provide many other contextualizing cues as well. There is also salience-based signal enhancement. Our needs and goals are factored in. Schemas also function as contextualizing effects. In most cases, substantial contextual information is already in place when new information arrives (see pp. 173 and 263 in *Surfing Uncertainty, on* the contextual effects of early learning and structurally implicit expectations).

General frameworks, or strongly held and long-lasting values and beliefs, may function as early context effects, shaping or filtering the information flow, especially when they are unconscious. This is a way in which ideologies or belief systems can have a powerful influence on mental activities and behavior, ultimately reinforcing or modifying social structure and processes, which, in turn may affect our values and beliefs.

An educational process can bridge gaps among divisive views by fostering comparisons in a pluralistic society in which commonalities of values are sought. Out of such explorations, experiences may evolve in which diversity may bring compromise in selections focused on commonality so that divisiveness is mitigated and evolutionary progress is made. As to be discussed, games may be used to develop experiences in which collaboration in contrast to divisiveness produces better results than the polemics of winner takes all.

Human Brains Are Proactive Systems

Human brains are proactive systems that do not passively await sensory stimulation. Instead, they are always poised to act, trying to use what they already know to predict (and sometimes elicit) the current

streams of sensory stimulation before they arrive, using the incoming signals to select and constrain those predictions. They are constantly guessing the structure and content of the ongoing stream of sensory input, including the inputs which should result from their next actions and worldly interventions. They restlessly seek to generate hypothesized probabilistic information about distal causes for themselves, using the incoming stimuli to check and correct their best top-down guessing.

The shape and flow of all that guessing is modulated by the prediction errors (mismatches) of the incoming signal. Attention is a sharpening process directed to increasing the quality or precision of incoming sensory information. Weightings are given to bias specific sensory channels during processing, flexibly altering the moment-to-moment flow of information between neural areas. "Mission-critical" elements are amplified and enhanced. The flow of information is constantly reconfigured according to the demands of the task and the changing details of the internal and external context.

The Process Needs to Deal with Reality

Our world is highly structured, with regularity and pattern at many spatial and temporal scales, and populated by a wide variety of interacting and complexly nested distal causes. The hierarchical (multi-layer) brain is well-matched to the world in complexity. Prediction-based hierarchical learning yields the emergence of higher-level abstractions that allow the system to predict the regularities (distal causes) that are governing the neural patterns present at the lower levels. Top-down and horizontal connections try to build-up a model of the sensory scene based on hypothesized knowledge about the probability of worldly causes, as a basis for forecasting what we will see next and to devise next actions.

In the classic sense-think-act processing cycle, sensory stimulation must be fully processed, and a structured world of external objects revealed, before actions are selected, planned and (ultimately) executed. This classic cycle is not appropriate for our reality where there is a need to respond to unfolding – and potentially rapidly changing – situations. Responses are required at short notice to grasp opportunities and avoid dangers and to act in competition with others.

The brain will sometimes intervene in the world so as to bring some predicted states into being, keeping us viable and serving our needs, but this may give us a less than fully accurate picture of reality as a basis for our behavior. People with different visions of reality can move to bridge gaps by engaging in a learning process. As a result, intervention in the world can result in predicted outcomes that come closer to reality than those fashioned out of misunderstandings of the nature of the invisible hand and so-called *free markets*. This is discussed in a related work by Maury Seldin titled *Common Sense Revisited: America's Third Revolution.*

Brains Are Complex Adaptive Systems That Self-Organize

Self-Organization: A Key Cognitive Process

Human brains fluidly self-organize to create brand new systemic wholes, integrating relevant information from many widely separated areas of the cortex. Information may also be incorporated into a systematic whole from outside of the brain in embodied and extended cognition. The system is adaptive by way of the outcomes resulting from its interaction with its environment. There are various processes that work together as inputs to the self-organizing of mental structures.

The self-organizing process is a primary basis of thinking and perhaps of most conscious mental activity that involves such organizing of diverse and relevant information. The organizing of the self-organizing process happens because of the modes by which information and sub-systems in the brain are mutually

related and interdependent. The operation of these modes functions to make the organization happen, rather than a controlling source external to the system. Self-organization and the emergence of global properties from the interaction of diverse parts are defining characteristics of complex adaptive systems like the human brain.

The Extended and Embodied Mind

As part of generating model hypotheses and resultant expectations, human brains self-organize to create new mental structures. This includes constantly searching for opportunities to make the most of the reliable properties and dynamic potentialities of body and world; the result is what is known as the extended and embodied mind where additional resources are made quickly available that enhance the basic mind.

Clark explains that the brain deploys an information-disclosing or problem-solving routine that directly factors in the availability of certain types of information by certain types of embodied action. In this way, non-biological informational resources can become deeply incorporated into a defined whole that is geared to automatically exploit, on a pretty much equal footing, both internal and biologically external forms of information storage.[See page 34 in *Supersizing the Mind*.]

Webs of Communicating Individuals

Socially interacting humans benefit from nested and reinforcing cycles of ongoing mutual prediction. This kind of joint piggy-backing emerges naturally when groups of interacting, individuals construct a shared social world. Webs of communicating individuals collectively explore complex situations of ongoing interacting events that would rapidly defeat any single individual. This is a call for team formation in dealing with highly complex situations.

Humans Help Construct Their Worlds

Most scaffolding efforts (external and internal symbolic storage) work well in reducing the complexity of the environment and of the internal thinking space, as a mutually reinforcing pair pursuing a common agenda which are available for thought and action. Explicit symbolic structures in the individual's environment together with explicit symbolic structures in her head contribute to dealing with a situation or problem at hand.

The combined effects of action, cultural learning, the use of language, and the many forms of socio-technological scaffolding are transformative. There is a very real sense in which humans help construct the very worlds they model and inhabit.

The great challenge is to organize as integrated teams in order to get a better understanding of reality. This can facilitate a blending of disciplines in order to get closer to reality of expectations.

Fostering Empowerment through Effective Learning

The Thinking Process as a Feedback System

An Action Orientation

In our predictive processing, we try to "guess the world". These predictive guesses are apt attempts to support our cycles of action and intervention, seeking to achieve goals while avoiding surprising or dangerous encounters. Our model's hypotheses are intended to put us in touch with the world in a way that will enable us to select better actions, parsing reality so as to facilitate our engagement with that

world. In this process, we sample the world so as to both reflect and test the hypotheses that generate the predictions.

Our actions selectively disclose predicted sensory stimulations, yielding better information for the control of the action itself. We behave in ways that are sensitive to the contingencies of the past, and that actively bring forth the futures that we need or simply desire. We turn prediction into action and accomplishment by predicting the near-future and then acting to call forth the very world we believe we know.

Individual Bias and Unconscious Mechanisms

One's perception is biased by the baggage of her experiences, the accumulated learning in memory of her life to date. What has been experienced and learned can serve as prior knowledge in the generation of models and other mental structures. It can also channel attention processes in perception and action.

Another kind of bias is the many unconscious mechanisms that operate where people's actions are at odds with their intentions. People tend to rationalize these actions away --- they even may claim ownership for these actions they had not intended. These two possible sources of biased actions may be a partial explanation of why the Republicans in the U.S. Senate have great difficulty in reaching a compromise in their legislative proposals.

Clark tells us that understanding these two types of bias and their effects may have social and political consequences. At the very heart of human experience, predictive processing suggests, lies the massed strata of our own (mostly unconscious) experiences. Unconscious bias influences people subtly, not overtly. It may cause serious errors of judgment and unwarranted confidence about their conclusions. This means that we must carefully consider the shape of the worlds to which we (and our children) are exposed.

As Clark further explains, if *predictive processing* is correct, our precepts may be deeply informed by non-conscious expectations acquired through the statistical lens of our own past experience. If (to take just the glaring obvious example) the world that tunes these expectations is thoroughly sexist and racist, that will structure the subterranean machinery that actively constructs our own future perceptions – a potent recipe for tainted "evidence", unjust reactions, and self-fulfilling negative prophecies.

Biological Endowment and Life Experience Empower Us

The genes and memes, as they empower the impact on the development of an individual, result in a history of many experiences. In this connection, an important transition was made by Kant in 1781 with his *Critique of Pure Reason*: He concluded: "That all our knowledge begins with experience there can be no doubt, [but]… it does not follow that it arises from experience."

Bryan Magee, in his *Confessions of a Philosopher*, tells us that "The attempt leads him [Kant] into the most radical reconstruction of the theory of knowledge that anyone has ever carried out. At the end of it he pronounces that the whole nature of the world as we experience it is dependent on the nature of our apparatus for experiencing with the inevitable consequence that things as they appear to us are not the same as [things] as they are in themselves."

Prediction Process Supports Action and Outcomes

Expert prediction of the world combines with the expert prediction of the sensory flows that would, in the given context, jointly characterize the desired action. Proprioceptive predictions actually play the

role of motor commands that bring the action about. Outcomes of our actions provide feedback informing the next action and perception cycle.

Clark explains how we alter our predictions to fit the evidence and seek out the evidence to fit the predictions. Predictive processing entails these two strands of activity constantly working hand in hand to reveal the causal structure and dynamics of our world, in interaction with our needs, projects and opportunities. (See page 124 in *Surfing Uncertainty*.)

At shorter timescales, we sample the scene behaving in ways that reflect and seek to confirm the grip upon the world that structured the sampling, recruiting an interwoven mesh of percepts and world-engaging actions. At longer timescales, we build designer environments that characterize the desired action, installing new predictions that help determine our behavior. These designer environments incorporate a cyclic process at the environmental level that is akin to and mirrors to some extent the inner thinking cycle. We thus build worlds that build minds that expect to act in those kinds of worlds.

Learning Process Builds Knowledge and Action Potential

Human interaction with the world is a dynamic endeavor where we attend to and process streams of sensory stimulation, ultimately generating sequences of motor actions, which in turn guide the further production and selection of sensory information. As these perception-action cycles unfold, models are generated which serve as the basis for expectations about the next stimulus array and the actions which one's behavior will cause. This can be seen as information-guided choice with self-structuring of sensory-motor information flows and the testing of expectations by self-generated actions.

This enables a learner to promote learning, creating or eliciting good data for herself and for others by what Clark terms reciprocal causation. Think of a dancer, whose bodily orientation is continually affecting and being affected by her mental states and structures, and whose movements are also influencing those of her partner, to whom she is continuously responding. Learning transforms understanding. The learner becomes the manager of her interactions as a coordinator locked in a complex process of action-reaction, rather than as a pure agent who undertakes actions and awaits consequences. (See page 277 in *Surfing Uncertainty,* on how a new concept may be deliberately constructed.)

Cognitive Extension of the Mind Empowers Effective Action

Cognitive extension can contribute to effective action, as information, strategies and routines acquired or accessible from environmental sources inform decisions and result in empowered and effective outcomes. Access to technology and useful cognitive structures can also advance empowerment.

Clark cites the cognitive extension example of the contrasting behavior of Otto and Inga. Otto is an Alzheimer's patient who uses a notebook as memory. He reads and writes in it. Inga is an ordinary person who uses her brain, mentally perceiving and acting to gain information. For both of them, remembered information is used in their mental processing in essentially the same way and they consider the "memory store", whether in a notebook or the brain, to be part of themselves.

He describes some of the ways mind extension can empower us as follows:

1. Development of Cognitive Niches and Thinking Spaces

Cognitive niche construction involves the active exploitation of space, actual physical space or virtual thinking space. Examples are spatial arrangements that simplify choices such as

laying out cooking ingredients in the order needed or mentally placing items to be remembered in familiar locations in a previously lived in house. Humans have extraordinary capacities as "environmental engineers"--- that is to say, as constructors of our own cognitive niches.

2. Language Scaffolding and Labeling

Language is conceptualized by Clark as a form of mind-transforming cognitive scaffolding, a persisting, though never stationary, symbolic edifice which can promote thought and reason. Having such a linguistic structure supports the discovery of increasingly abstract patterns in nature, makes it easier to encounter or recall structured sentences, and contributes to our ability to reflect on our own thoughts and characters, and to our limited but genuine capacity to control and guide the shape and contents of our own thinking.

The simple act of labeling the world can augment reality. By mentally recalling labels, we can reduce a higher-order problem to a lower-order one. Complex properties and relations are artificially reconstituted as wholes. This enables us to use simpler processes of selective attention and process control to accomplish a task or solve a problem by reflecting on our own thoughts and thoughts processes. It is sometimes possible to think solely in terms of the wholes 'the labels' without reference to the parts "the things labeled."[See page 44 in *Supersizing the Mind.*]

3. Environmental Resources and Epistemic Actions

Access to environmental resources, accessible as scaffolding of structures of knowledge, skills and/or technology, may form a base for empowering others and of self-empowerment. Epistemic action (physical or mental behavior seeking to change your information-processing to make it easier, faster or more reliable) can build or enhance such structures. These actions can be initiated directly by individual internal processes akin to software subroutines, yielding changes in the world that generate (just in time) the information required by that very subroutine. Multiple subroutines, operating at different timescales,can draw on each other to affect both inner mental processes and outward-looping epistemic acts, resulting in episodes of closed-loop interaction between environmental scaffolding resources and mental processes.

Critical Thinking Skills

Critical thinking skills and techniques can help learners comprehend topics or subjects so they can see the parts in terms of the whole, to become active learners rather than passive recipients of information. They learn to think more critically, seeking to understand a topic's purpose, the main questions it raises, the conclusions reached and their implications and probable consequences. In other words, critical thinking approaches the world, employing thinking that is skillful, sensitive to context, responsible, relies on criteria and is self-correcting.

Learners employ critical thinking to address a question or problem they wish to understand by seeking to learn about a relevant topic. They think it through using the elements of reasoning, and they monitor their reasoning and learning using quality standards. The goal is to gain comprehension of how the parts or ideas of the topic fit together into a coherent whole that may be effectively applied to address the problems and opportunities of their life situation.

Effective Learning Techniques

Moser's ways of effective learning can be seen as a kind of scaffolding. They collectively form a structure or framework comprised of learning skills and techniques intended to enhance the quality of learning. Successfully employing these skills increases motivation and confidence. Experience in networks and relationships gives us reasons to seek increased informational power through learning.

Motivation can be built by employing the effective strategies previously suggested of (1) seeing the value and meaning of a topic, (2) gaining a comprehensive initial grasp of the ideas presented, (3) practicing using those ideas, (4) getting timely feedback about outcomes and (5) applying your knowledge to gain understanding of the underlying system being described and explained. These skills and practices are all needed components of a valuable and motivational approach to learning.

Along the way of a learning episode, feelings often serve to tell us how well we are doing in our discovery and learning process. Our peers may promote the topic's value and help us see meaning in it.

Gaining Increased Empowerment

For the learner, empowerment involves preserving existing capacities to exercise power or gaining additional capacity to do so. In particular, effective learning enhances the learner's net informational power and her motivation to learn. Informational power includes information or the access to information, cognitive processing skills, and understanding of the domain, material or situation of concern.

The effective learning processes advocated by Clark and Boser focus especially on increasing understanding as a target of the process, where understanding involves having insights or good judgment and the ability to perceive the significance, explanation or cause of something, essentially to be able to figure it out. For instance, the learning strategies of testing, practice, retrieving ideas, explaining them, etc., will significantly enhance learner understanding.

As she moves through the process, the learner will be progressively more able to think about an abstract or physical person, situation or topic whereby she is able to use concepts to deal adequately with it and know its meaning. Increased motivation to continue learning emerges as one gains understanding and informational power.

Main Points and Next Steps

The main points in this essay hover around the process of learning as a subset of thinking that is built around a start of expectations when sensing situations. Those expectations arise out of experience. The challenge is to provide the learner with experiences more closely related to reality based upon an understanding of how complex adaptive systems really work. This is in contrast to expectations based upon explanations built from analysis of shadows on the wall as discussed in Plato's Allegory of the Cave.

Boser tells us that the key attributes of effective learning are understanding, creativity and persistence. Clark's theory substantially incorporates learning strategies directed to advancing these key goals in explaining perception and adaptation. Education that embraces these important features, enhancing the learner's informational power, will indeed foster empowerment through effective learning.

To be explored in our subsequent work is the use of games as part of the process of providing the learner with experience. In its simplest form, it is in the selection of games taught to children. This

especially includes games requiring cooperation as well as competition. In more advanced forms computer simulation game models provide essential opportunities.[iii]

Ideas and research about how the educational process can become more effective are needed to relate this essay's conclusions and implications to the larger project of advancing education for a viable democracy. How might this be done is under exploration.

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[ii] Dr. Maury Seldin, a chaired professor emeritus of The American University School of Business Administration, was the founding president of the Homer Hoyt Institute created to serve as the research arm of two of the schools programs. He is Chairman Emeritus of the Homer Hoyt Institute (HHI), founded in 1967 and Chairman Emeritus of the Maury Seldin Advanced Studies Institute (ASI), founded in 1982 and serving as the corporate home for the Weimer School of Advanced Studies in Real Estate and Land Economics. Dr. Seldin is co-leader of the Seminar on Strategic Decisions at ASPEC, an interest group that he founded in 2002 and that in recent years has focused on applications of complexity science to a variety of strategic decisions ranging from personal health to organizational management and societal issues.

[iii] An example is a computer-based game used decades ago. The following is an excerpt from An Environmental Laboratory for the Social Sciences book. The chapter is titled "American: City Model Usage for Courses in Real Estate and Urban Economic Development." It was at the American University in Washington DC. The book was published in 1972. The excerpt was in a monograph titled The Challenge to Our Thought Leaders - The Hoyt Group. The monograph was published in 1973.

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COURSE OBJECTIVES

The purpose of the course is to improve the quality of real estate and urban development decision-making through the use of a body of knowledge. This objective is sought through the education of students who are or may become the decision-makers. The course is designed to give them an opportunity to conduct the analysis which leads to the decisions and to see the consequences of those decisions and subsequent actions. This gaming approach is different from the term project approach in that in the Game they make the decisions and have the opportunity to implement them. They receive a feedback from their actions. In addition, other forces are constantly at work which alters the effectiveness of their programs for achieving the objective they set forth. They therefore have a learning experience in how to deal with the changing environment. The round-by-round play gives them the feedback so they get significant experience in selecting the type of analysis which is necessary to move them toward their objectives. The allocation of their time as well as of their Game resources is a critical determinant of the success they hope to achieve.

The course is designed to enable them to improve their analytical ability. It starts out geared to the developer-investor and others who are primarily concerned with individual parcels of real estate. But as the course develops, it is obvious that these decisions must be looked at in terms of what the rest of society is doing.

The resultant administrative process integrates decision-making through the various disciplines. As the Game progresses the students see that they are at sufferance of the environment in which business needs to perform its functions. They increase their involvement in the management of that environment. They apply the

same administrative processes to the management of that environment. They then learn more about the relationship between business and society.

The types of analyses at the micro-level include market analysis for shopping centers which are simulated by "personal goods" and "personal service" industries. Other market analyses are used for various types of property to be developed. Appraisals need to be made for various purposes. Business and property analyses are made in order to improve profitability of the enterprises. Investment portfolio analyses are conducted. In a sense, the economic teams manage a variety of business enterprises and a portfolio of real estate resources. Unfortunately the income to business and the income to the real estate are not separated. But, the student is able to explore the application of principles which he has learned in his real estate and business administration courses. He also finds that human relations and leadership qualities become important determinants of his success.

At the macro-level the objective is to improve the student's understanding of how the system works. He does this by assuming a public role in which he does the planning and zoning or provides the transportation facilities or utilities, or he may be mayor and coordinate public sector efforts. The Game is so devised as to provide the feedback which can be used as a measure of the quality of performance of these various public sector functions. The student then sees how the proper (effective?) functioning of government influences the proper (effective?) functioning of business, or perhaps more correctly how the improper (ineffective?) functioning of government adversely influences the proper (effective?) functioning of business.

Since the public and private interest become interwoven, the Game provides a good way of demonstrating decision-making in a society in which there is some community of interest between the public and private. The class determines its own standards of morality. A system of ethics and law develops in a way that enables the society to function. The set of values varies with the student group, but whatever the values, they show through in the operation of the Game.

The operation of the public sector provides significant opportunities to apply analytical techniques for public decisions in much the same way analytical techniques can be used for profit-oriented decisions.

For example, a school location decision is not so different from a shopping center location decision. Experience in the Game shows that the private sector decision-makers do use that knowledge of analytical techniques for public sector decisions.

The public sector demonstrates a need for balance in the system. The balance is not only in the provision of public facilities but also in the private development of the appropriate mix of land uses.

One of the great lessons of the Game and of the course is that the urban development process may be managed by providing an environment in which the private decision-makers pursuing their own objective respond to public sector objectives. They build where the facilities are available and at the best place to serve the markets. Since the public sector can control the locations where the facilities become available, there is an opportunity to be socially and politically, as well as economically responsive. An efficient system can be developed by developing balance.

The inefficiencies become expensive not only to the developers but to the community as a whole, so it becomes evident that it pays to have an improved analysis of the problems of managing the environment in order to achieve public objectives, whatever they may be.

In CITY MODEL the public objective decision-making is complicated by the presence of a separate social sector which is generally muted in the classes under discussion. Some development may take place in activating this sector. But the social sector receives little attention because of the small size of the class and the entrepreneurial tendencies of the students generally, as well as because of the selection of students.