The Transfer of Learning: The Meaning of Learning Itself

"*Tell me and I forget. Teach me and I remember. Involve me and I learn.*" Benjamin Franklin

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[1] In this, and all my other essays, I will periodically add applicable supplemental information as new information becomes available. Therefore, this published year refers to its first release to the public.

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Introduction

Fundamentally, the problem with our educational system – besides the destructive nature of centralization of government power – is this: It has been optimized for a particular set of talents that serve approximately 15 to 20% of the school age population. These talents are the ability to memorize and recall raw, disconnected data for assessment tests – the gateway to lucrative credentials. Though roughly 40% of the current population may have a college degree – associate to graduate levels – around half of this population has been ill served by a highly self-serving postsecondary culture that has optimized the educational system for itself at the expense of all others. This culture's negative influence then trickles down throughout the primary and secondary grades, benefiting a few but alienating a majority to varying degrees of injury. It is my intention to expose how the system has been optimized and how it harms individuals, which in turn, harms society in a multitude of ways.

This essay is intended to guide Applied Education Foundation researchers in exploring curriculum design for all learners in the school age population, excluding special learner needs. The design's focus will start with establishing solid literacy and numeracy wherewithal and then to establish a solid foundation in the needs of individuals to flourish in a complex civil society, which encompasses a grounding in applied civics, marriage and the family, applied health and science, applied economics, and how it all ties together. The capstone of such an education program will lead to some form of career training that suits an individual's talents and desires. After all, whether one seeks credentials in some trade or chooses to pursue a credential in medicine, all careers require training.

With such goals in mind, research by cognitive psychologists to achieve efficiencies and effectiveness in this endeavor will provide the cornerstone of all curricula, with special attention given to: the use of inductive reasoning in explaining how discoveries were made; grounding in first principles/axioms upon which all subsequent instruction will be built upon; analogous explanations and examples to offer triangulation that will provide understanding of these first principles; and useful real-world application of subject matter taught to provide comprehension of material as opposed to a shallow storage of mere facts.

In all, the development of cognitive reasoning abilities will be at the core so that higher transfer of learning will be more commonplace than is currently the case due to a failed education system.

The cognitive psychologist Daniel Willingham (2009, p. 87) provides some insight into why teaching mere abstract facts is ineffective. He asks the simple question, "Why is it so hard for students to understand abstract ideas?" He answers,

> The challenge is that the mind does not care for abstractions. The mind prefers the concrete. … We understand new things in the context of things we already know, and most of what we know is concrete. Thus it is difficult to comprehend abstract ideas, and difficult to apply them in new situations. The surest way to help students understand an abstraction is to expose them to many different versions of the abstraction….

That is, to apply them to many real world scenarios that use the teaching techniques of triangulation, analogies, and inductive reasoning which when combined will establish a concrete understanding. Only then is transfer of learning possible.

Grandin (p. 60, 2022) shares the thought that "humanly meaningful context informs our thinking. We need ideas to be connected to real-world examples in order to grasp and implement them."

Grandin then references research that uses the term

> ‘disembedded’ to describe things without a context or direct experience to ground them. These skills, ‘underlie our mathematics, all our science, all our philosophy. It may be that we value them too highly in comparison with other human skills and qualities, but we are not likely to renounce them. We have come to depend on them too much.’ [T]he education system rewards those who ‘get it’ and leaves the rest with a sense of profound failure. That failure, it turns out, is more pervasive than I had imagined. (pp. 62-63)

Currently, abstract concepts taught in public education are distantly associated with application and typically not associated with axioms at all. They are floating ideas with no substantive grounding presented by the education system. This is why memory and recall alone are so important – the abstract ideas are mere data points with little to no associations to anchor to.

Personal communications with Paul Murrin (educated in applied math) provides an interesting perspective on teaching abstract concepts:

> Lectures are a less effective way to teach because complex systems of data cannot be expressed effectively and efficiently by something as linear as oral communication. Written word is linear too, but at least one can go back to recall the premise of a given explanation. Complex systems of data, such as in advanced mathematics, must be understood through experiencing the examples of their key elements. We must avoid purposefully, and in many cases maliciously, designing curricula to be overly challenging (shrouded as academic rigor) as is currently done by modern educators in secondary and postsecondary education. It is a contradiction to think that making things more complicated (challenging) is going to help a confused individual achieve clarity, but then, this is not the intent of many educators who believe their job is to select for the “best and brightest.” Instead we need to view experience as work that leads to comprehension. Yes, work involves effort, but not based on the deceitful concept of “academic rigor.” Only by working directly in an applied manner with some topic, can one come to understand it. Being told what something is will not satisfy the human mind; we must come to know it for ourselves through direct applied experience.
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> Challenges couched in academic rigor are for satisfying one’s ego more than anything else; it’s to prove one’s worth or social value. However, if challenges are not used for one’s selfish gain in academia then they are frequently used for something worse – to separate people from one another according to *their* worth; ordering them in such a way that one person can be distinguished as more valuable or important than another. The vanity of this perspective is extremely dangerous. It allows for the highly ranked few, who were selected by an arbitrary institution, to dominate the majority; leaving the lowly ranked sector in poverty. This is the current state of society, though nobody likes it, but no one knows of a better way and few try to discuss or figure out how to improve conditions. This is due to the fear that admitting one does not like the system is to admit that one does not benefit from the system, which in turn, admits a low rank due to the lack

of academic abilities, implying that he is an imbecile. It is much like a teenager admitting that he does not like sports, which, in the eyes of athletes, would invalidate his opinion since only incapable people would dislike sports. One is therefore seen as a loser if he criticizes academia or the sports culture. This erects high barriers to innovation and change.

The Use of Analogies

Throughout this essay, I ask the reader to keep an important thought in mind: The use of analogies has been a dominant method of instruction, going back to at least Greek antiquity, but has received little attention in educational literature, except Willingham (2009). Throughout my essays, I use analogies on a regular basis to get points across. These analogies provide a panoramic view of a principle that is difficult to get across in any other way. Making such comparisons provides the reader with a fuller and richer understanding of the point I am attempting to make.

Historically, literature has been used to teach moral lessons (think of Greek epic poetry and Aesop's Fables). Fictional stories provide the backdrop that demonstrates such lessons, which allows for the full consideration of moral questions. Writers wishing to make a moral point have historically used fiction to "preach" their "sermon" through a fictional setting so that readers will understand and embrace the principle almost subconsciously. That is, by offering the lesson through an entertaining venue – rather than in a preaching manner – the reader feels as though he discovered a new moral lesson on his own rather than by someone telling him what to think or do. He therefore takes full possession of it and adopts the lesson with pride for having made such a wonderful "discovery."

While rote memorization and techniques of practicing something until it has become habituated in a person are dominant instructional methods that have been used throughout history, they do not provide the depth and breadth of understanding that analogies offer. While rote memorization and repetition provide a shallow understanding for *close transfer*, using analogies from different angles provides the opportunity for full comprehension and therefore the prospect to achieve *far transfer*. Rote, practice, and analogous methods of instruction are not mutually exclusive. Rather, they can compliment each other very well.

Even though the analogous teaching method has been a dominant technique for at least two millennia, I can find no evidence of it being formalized in public education curriculum. It appears to be predominantly a method adopted by individuals as a personal and informal method of instruction. Perhaps this is due to the difficulty of identifying the correlation between the principle one wishes to get across and stories that make the point.

The Importance of Transfer of Learning

Issues addressed in this section may prove to be somewhat redundant in clarifying the importance of transfer, but as Willingham points out, for something to be learned broad

and deep enough, a subject must be analyzed from various angles before it is understood – i.e. triangulation.

In Quick's (1894) analysis of John Locke's work, *Conduct of the Understanding* (1706), he provides "Till we ourselves … perceive it by our own understandings, we are as much in the dark and as void of knowledge as before, let us believe any learned authors as much as we will." It is certainly necessary to learn from others and to stand on the shoulders of those who have gone before us, but if one is not able to make it one's own by absorbing it with a solid understanding, it is not knowledge, but merely stored data like in a computer.

With this understanding of the difference between truly knowing and simply memorizing, let's proceed to explanations of transfer of learning.

The importance of transfer is too great an issue to provide a simple explanation and therefore hope that all readers will easily grasp what's at stake; however, the concept of the Gordian Knot[2] provides a perspective of solving a perceived complex problem with a simple solution that eludes most. With such an analogy shedding some light on the idea of *transfer*, I would like to clarify what transfer encompasses, so not only will this essay be fully digested, but all the other essays I offer will also be better understood, since everything related to education rides on transfer.

Mestre et al. (2005) sum it up well: "Recently, we argued that the first and only instructional goal should be to teach for long-term retention and transfer. Of course, we are not alone in this; rather, we are members of a chorus declaiming the importance of transfer…." (p. 360) However, we are a far cry from the acceptance of this concept.

Again, Mestre et al. has this to offer regarding the role of education: "The fundamental idea behind education is to teach knowledge and skills that will allow one to function better outside the classroom." (p. xiv) They also offer this as a description of measuring transfer: "[T]ransfer [is] measured as [the] ability to apply knowledge flexibly across varying contexts." (p. xxi) Combine the ideas expressed in these two sentences and we get: *Education is to teach knowledge and skills that can be applied flexibly across varying contexts outside the classroom.* Currently, this is done only in career technical education (CTE) classes or college programs that are also career oriented in applied realms such as engineering, medicine, finance, etc. These types of college programs really are CTE oriented, albeit in later educational years. However, many academics mistakenly feel they are above career-oriented training, unless it is in the university setting, which provides the necessary aura of status they relish.
As it relates to determining the effectiveness of teaching strategies for transfer, Mestre says,

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[2] The Gordian Knot is often used as a metaphor for an intractable problem (untying an impossibly tangled knot) solved easily by finding an approach to the problem that renders the perceived constraints of the problem moot ("cutting the Gordian knot"). https://en.wikipedia.org/wiki/Gordian_Knot

> Multiple researchers have looked at the effects of schooling on transfer to everyday situations, often with gloomy results. … [M]ost transfer-inspired methodologies cannot detect whether school prepares people to learn more effectively than if they had not had school experiences…. (p. 41) An instructional program that successfully inculcates skills, but for which the skills do not transfer to nonacademic situations outside the classroom, is a failure. Simply put, no one cares about learning if it stops at the schoolhouse door. (p. 295)

However, many academics understand only how to teach for more schooling. This is due largely to the design of curricula, which is disconnected from real-world needs.

Mestre (pp. 361-62) provides an outstanding quotation summarizing the problems with public education:

> "[E]ducation makes little effort to teach individuals to examine reality directly and freshly. Rather it gives them a complete set of prefabricated spectacles with which to look at the world in every aspect, such as what to believe, what to like, what to approve of, what to feel guilty about. Rarely is each person's individuality made much of, rarely is he encouraged to be bold enough to see reality in his own style, or to be iconoclastic or different. Proof for the contention of stereotyping in higher education can be obtained in practically any college catalog, in which all of shifting, ineffable, and mysterious reality is neatly divided into three credit slices which, by some miraculous coincidence, are exactly 15 weeks long, and which fall apart neatly, as a tangerine does, into completely independent and mutually exclusive departments. If ever there was a perfect example of a set of categories imposed *upon* reality rather than *by* reality, this is it." [Maslow, A.F. (1954), *Motivation and personality*. New York: Harper, p. 284]

Haskell (2001) provides an excellent account of what transfer is and an analysis of our educational system's failure to provide for it. He quotes James Desse (*The Psychology of Learning*, 1958) emphasizing the significance of transfer in education:

> There is no more important topic in the whole psychology of learning than transfer of learning … practically all educational and training programs are built upon the fundamental premise that human beings have the ability to transfer what they have learned from one situation to another. (p. 3)

Haskell provides further emphasis on the importance of transfer:

> The aim of all education, from elementary, secondary, vocational, and industrial training, to higher education, is to apply what we learn in different contexts, and to recognize and extend that learning to completely new situations. Collectively, this is called *transfer of learning*. Indeed, it's the very meaning of learning itself. Although some disagree, most researchers and educational practitioners … agree … that meaningful transfer of learning is among the most – if not *the* most –

> fundamental issue in all of education. They also agree that transfer of learning seldom occurs. (pp. 3-4)
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> The issue of transfer, then, is an extremely serious one for individuals, schools, business, and society. It's especially important given findings that the average person will change vocations (not merely job locations) five times in the span of his life.[3] The particular information and concrete strategies learned to navigate one's chosen profession quickly become outmoded, not once but many times. We need to teach information and thinking that will transfer. (p. 5)
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> … [T]he concern about transfer of learning becomes increasingly salient in a world where rapid scientific and technological change often penalizes those who are narrowly skilled and mentally inflexible. (p. 6)

This last paragraph is the motivating factor that drives my passion for an applied education program. My understanding of the collapse of the U.S. steel industry and the devastating effects it had on steel workers who were "narrowly skilled and mentally inflexible," and the subsequent economic ruin they experienced, made me take a serious look at the causes of this catastrophe. My findings have led to the essays I have written.

The fact that individuals change vocations multiple times during their working lifetime, demonstrates the need for a broad education as it relates to what drives an economy – and not just abstract, theoretical macroeconomic concepts. Students need to be exposed to the primary economic sectors (agriculture, manufacturing, extraction & processing, and service industries) and their interrelationships in order to fit the pieces of the economic puzzle together. In this way, a commanding view of the economic landscape is better understood and appreciated, thereby providing clearer paths to various opportunities as times change and the need arises. It also provides the means to being well-informed citizens in a republican form of free government.

With such a commanding view, learning for transfer is made easier since it is through the connecting of dots that transfer really takes place. While this last statement may not be clear to many in academia who operate in isolated and disconnected environments, it is clear to businessmen who face complex real world scenarios that require adaptation, innovation, and decision making on a constant basis in an ever changing world. Academics have the leisure to focus on one discipline without fear of failure, while businessmen must coherently juggle multiple disciplines in a sink-or-swim environment.

Haskell points out what's at stake:

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[3] Yet it is interesting to note that one of the primary arguments against career training during the secondary years is based upon the premise that students are not likely to know what they want to be prior to completion of secondary education (as though they miraculously will discover it once a diploma is placed in their hands). In addition, college students frequently change majors since they find it hard to make a final decision. After graduation, many don't even pursue jobs in their field. Then, based on the reality that, on average, individuals change careers 5 times during their working life, it appears that few people know what they want to be when they grow up. So the argument against career pursuits during the secondary years is based upon flawed reasoning.

> Our future depends on our ability to transfer what we learn, for it's the transfer of our learning that creates our understanding of peoples, that creates technological innovation, that creates scientific discovery, that creates our competitive and cooperative edge in a global market…. (p. 8)
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> As Frank Pratzner concluded years ago, occupational adaptability is based upon individuals "who can generalize, transfer, or form associations so that the skills, attitudes, knowledge and personal characteristics that have been learned or developed in one context can be readily used in a different context." (p. 9)

Such issues define the need for a broad based applied education program. Using what one learns provides greater depth and breadth of understanding that cannot be accomplished through lectures or textbooks alone. Theory must be coupled with application to gain the greatest depth and breadth of understanding.

A good analogy to get this point across is something I've experienced first hand. I am qualified as an instructor in a Korean martial art called Hapkido – I'm a 5th degree black belt based on a system of 8 degrees. I assisted my instructor, who was an 8th degree, in teaching students in the evenings for many years. I have unequivocally concluded that, with no prior hands-on training in pugilism, an individual cannot possibly be proficient at the martial arts if only provided instruction based on lectures and access to textbooks. However, once an individual has become proficient at a martial art, it is easy to transfer one's knowledge and ability to new techniques never seen before. In other words, a proficient martial artist can look at pictures in a book showing a technique he never learned before and easily utilize it quite effectively. This is how transfer works.

Sports provide the same analogy as the martial arts. One cannot learn sports through textbooks and lectures alone. They have to be experienced for one to become proficient. This establishes an example of why many teachers in public education have a hard time teaching for transfer: without real world experiences in their given discipline, teachers' depth and breadth of understanding are not sufficient to know how to teach for transfer. They do not possess applied experiences that are so important to fully comprehend and therefore teach what needs to be learned at the relevant levels. In other words they cannot discern what is appropriate and what is superfluous. When this discernment is absent, the ends of instruction become a ball of confusion.

Another analogy is in order: When I graduated high school, I spent time in the Rocky Mountains, the Cascades, and the Pacific Coastal Range trying to live off the land. I had studied books on what plants to eat and how to extract food from the sea for a few years prior to this adventure, but when I actually tried to apply what I had learned from books, I found myself distressingly incompetent. I managed to gather some foods, but not enough to sustain life. At age 17, I concluded that one cannot learn to be proficient if instruction comes only from books. The same is true of everything we learn in our public schools.

Another point to make: Think of an individual going into the construction industry. Going through a CTE program in high school that provides instruction in carpentry, for example, is a very good start since it is an applied study. However, what if this individual wanted to start up a business down the road or take some supervisory or managerial position in a company? Without foundational instruction in business management, the odds of success are significantly reduced. By combining hands-on experience and applicable theory through a CTE program, coupled with instruction in the theories and practices of business management, the depth and breadth of understanding is increased dramatically providing a foundation that increases the likelihood of success. All math classes would be of a technical and financial nature. All language arts classes would also be geared toward technical communications. All science classes would be associated with applied engineering and material science concepts. Geography classes would be correlated with raw material extraction, processing, manufacturing, and service industry regional features. And so on.

The last point to make applies to those going into the innumerable technical fields, as well as those going into engineering and the physical sciences. The history and evolution of technology, beginning with hunting and gathering technology – starting in 6th grade – and continuing technological instruction up to contemporary times through the high school years, would provide a solid foundation in an understanding of transfer if taught in the correct manner.[4] That is, by recreating the challenges that were faced under contemporaneous circumstances throughout history and then how challenges were resolved through innovation (an example of the use of inductive reasoning instruction), this would demonstrate just how transfer works and how individuals might learn how to transfer in a multitude of ways. Comprehension of such diverse ways strengthens the ability to transfer since it broadens the mind and deepens understanding.

What is Transfer of Learning?

"Transferable learning goes beyond knowing to *doing* what one knows." (Mestre, p. 362) I think Quick's (1894) analysis of a saying by Michel de Montaigne (1533-1592) provides another angle to grasp Mestre's idea.

> Perhaps the saying of Montaigne's which is most frequently quoted is the paradox "To know by heart is not to know." But these words are often misunderstood. The meaning, as I take it, is this: When a thought has entered into the mind, it shakes off the words by which it was conveyed thither. Therefore so long as the words are indispensable the thought is not known. Knowing and knowing by heart are not necessarily opposed, but they are different things; and as the mind most easily runs along sequences of words, a knowledge of the words often conceals ignorance or neglect of the thought. … But there are cases in which we naturally connect a particular form of words with thoughts that have become part of our minds. We then know, and know by heart also. (p. 74)

[4] Consider the Society of Primitive Technology: http://www.primitive.org/about-the-spt/; and Penn Museum's applied sciences department: http://penn.museum/sites/applied_science/index.html and their research on the history of technology as useful resources toward this end.

Transfer of learning is the ability to apply knowledge learned in one context to new contexts. "The more skilled we are in transfer, the more creative and efficient is our thinking and performance." (Haskell, p. 24) It is frequently referred to as "transfer," "learning transfer," "transfer of training," etc. Fundamentally, there are two types of transfer: Near Transfer defined as: "Tasks are *perceptually* similar and behavior is triggered automatically"; and Far Transfer defined as: "Tasks are *conceptually* similar (follow the same rule) even though they don't look similar on the surface."[5] (Emphasis added.)

Mestre provides further clarification on near and far transfer:

> Near transfer referred to situations where there was a great deal of similarity between the conditions of original learning and the conditions involved in transfer learning, whereas far transfer involved little similarity between the two events.
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> One common way the difference between near and far transfer is discussed is in terms of school-learned events and out-of-school events (e.g., Royer, 1979). School-learned events are often described as involving near transfer since many of the conditions involved in learning one event are also present when another event is learned. In contrast, when school-learned material is applied to an out-of-school problem, it is said to involve far transfer since the stimulus complexes in the two situations are likely to be quite different. (p. x)

Near transfer is learned in our everyday social settings as well, and it is the primary focus of our educational system. This system fails to deliver in teaching for far transfer. Mestre states, "Tests often drive teachers to pitch their instruction to have students do well on tests, but this creates near transfer and not necessarily the type of far transfer that we desire for individuals to work well in society and in the workplace." (p. xxiii) However, far transfer is what is required for adaptation and innovation in the real world, but it is a diminishing attribute in our society due to: our contemporary educational system's inability to provide for it; the rigidity of our compulsory education laws that bar real world experiences during our youth's formative years; and because of "child" labor laws that make it exceedingly difficult for young people and employers to work together for their mutual benefit. All of this inhibits the development of transfer abilities.

Mestre offers further insight into what transfer encompasses. He provides the following about lateral and vertical transfer:

> The distinction between lateral and vertical transfer was made by Gagne (1965). Vertical transfer occurs when a skill or knowledge unit learned in one situation directly influences the acquisition of a more complex skill or knowledge unit learned at a later point in time. From Gagne's perspective, the simpler skill was a necessary precursor to the acquisition of the more complex skill and instruction

[5] http://www.utexas.edu/courses/svinicki/ald320/Transferohs.html

> should be arranged to take advantage of the hierarchical structure of information to be learned. …
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> Lateral transfer was less well defined in Gagne's (1965) system. He referred to lateral transfer as "a kind of generalization that spreads over a broad set of situations at roughly the same level of complexity" (pp. ix-xiv)

Business managers are immersed in lateral transfer. A company owner needs to juggle broad sets of situations daily. Finance, marketing, operations, etc. all need sufficient understanding to connect their relationships so that successful transactions may take place on a regular basis.

The Purpose of Education is for Transfer of Learning

Haskell provides further insight into evidence of the failures of transfer in education:

> Transfer of learning is our use of past learning when learning something new and the application of that learning to both similar and new situations. At first glance, it's very simple. Transfer of learning, however, is the very foundation of learning, thinking, and problem solving. Despite the importance of transfer of learning, research findings over the past nine decades clearly show that as individuals, and as educational institutions, we have failed to achieve transfer of learning on any significant level.
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> Time and again in the literature, beginning with the work of Edward Thorndike (1874-1949) in 1901 to the present, the verdict has been as Douglas Detterman observes: "If there is a general conclusion to be drawn from the research on transfer, it is that the lack of general transfer is pervasive and surprisingly consistent." In the preface to their edited book, *Teaching for Transfer*, Ann McKeough, Judy Lupart, and Anthony Marini lament, "Transfer of learning is universally accepted as the ultimate aim of teaching. However, achieving this goal is one of teaching's most formidable problems. Researchers have been more successful in showing how people fail to transfer learning than they have been in producing it, and teachers and employers alike bemoan students' inability to use what they have learned."

Transfer is at the core of what education is meant to accomplish: Prepare our youth for full participation in society. Since this is not being accomplished, some educators fall back on the tired cliché "Learning for learning's sake," in order to justify their incompetent system – and for a long time it was a fairly effective marketing ploy. While I am one individual who loves to learn for its own sake, it is not appropriate for me to demand that all others follow my passion for learning. Many people are far more practical than I, and would shudder to think of studying and writing to the extent I do. My passion for learning is a personal, subjective interest and therefore it cannot be understood as an objective social good. Given this truth, we must abandon the idea of learning for learning's sake – leaving this to individuals to pursue privately – and think of

the needs of all citizens; designing curricula that take all interests and talents/intelligences into account.

And let's get one thing perfectly clear: ***There is no one talent/intelligence that is superior to another***! Any who would disagree with this is an elitist and should be shunned by society. Each of us needs to be humble with the talents we possess. This then raises the political question: Are we or are we not all equal? Our Founding principles say we are. However, "equality" is , in some ways, illusory, since we are equal in the social/legal/political realm, but we are not "equal" in our abilities in any one field of human endeavor. This leads to economic compensation based on the law of supply and demand, which is typically arbitrary since it tends to depend upon the era one lives in or it depends on the barriers erected by governments on behalf of factions.

We differ dramatically in abilities and this must be embraced with gusto, since we don't want to mimic a beehive full of worker drones, as socialism would have us do. This is where an understanding of economic forces by individuals will lead them to better career decisions so that they will avoid saturated labor markets and instead, pursue careers where demand is expected to be high. Lacking an understanding of economic forces, many citizens will seek artificial protections and remedies through government force.

It is generally believed by the academic community that what is taught in formal educational institutions is readily transferred to theoretical as well as real-world applications relatively easily by "smart people." Cognitive psychologists over the last century have demonstrated that this, in fact, is not the case. However, belief systems die hard even when the evidence is overwhelmingly against such faith.[6] Therefore, our educational establishment needs to modify their ineffective curricula grounded in almost exclusively disconnected abstract data.

This helps explain why employers are not impressed with high school and college graduates' abilities to perform in the working world. Students were not taught to discern or reason sufficiently during their formative years.

There is a large disconnect between what is taught in schools (an almost exclusive college prep program disconnected from real world applications) and what is needed by individuals and society. Compulsory laws contribute to the problem since they provide monopolistic power (one-size-fits-all type of products/services) to educators and therefore inhibit useful and productive alternative learning experiences that rob our youth of opportunities that are so important during the formative years.

What's the Problem with Teaching for Transfer?

The problem with transfer is that, in large part, our educators do not know how to teach for it. For example: Civics and humanistic studies that incorporate the important lessons

[6] Consider Thorndike's early research, "The Influence of Improvement in One Mental Function Upon the Efficiency of Other Functions" (Thorndike and Woodworth, 1901) and his evidence that transfer was not being provided through public education even at this early stage of our bureaucratic educational system.

accumulated over millennia – both positive and negative – are ignored for the most part to the detriment of what it means to be civil. The gems of classical antiquity, of the Renaissance, and of the Enlightenment are ignored or forgotten.[7] These gems provide lessons to develop the ability to reason in individuals and thereby help them transfer learning in the realm of civics that is so important to a just and harmonious society as opposed to our current trajectory toward a dictatorial State where the subjective will of special interests is forced upon all others. Each faction believes its will is justified in being asserted against all others, but each believes no other faction's will should be asserted against it. This is a demonstration of an ignorant and dangerous perspective and it is prevalent throughout our society because those in our education system, generally speaking, do not understand these principles and therefore do not teach with such principles in mind. In many cases they teach concepts contrary to these principles thereby accelerating the path to a dictatorship.

Perhaps a simple lesson in comparing deductive reasoning and inductive reasoning can shed light on part of the problem with the absence of teaching for transfer. Kors' (1998) lecture on the intellectual revolution of the 17th century, addresses inductive and deductive reasoning. Inductive reasoning: "Drawing general truths from a large set of particulars. … Deductive reasoning begins with something known to be true and other truths are found to logically follow." Kors points out how deductive understanding becomes an authoritative reference point. "Once you know something to be true from a deduction by Euclid you can give an example of it in the world, an illustration. And indeed, many professors in the sciences today at our universities, rather than leading students through the inductive experiments that led to something being deemed true in chemistry or astronomy, will merely illustrate what they already know to be true."

Here lies a fundamental problem with our current system of teaching, which is at the root of the lack of transfer. Rather than demonstrating how a truth was discovered through inductive reasoning (that is, the steps in which understanding was established, which can be more important than the truth/fact itself) the truth/fact is simply fed to passive students who have no idea what to do with it and, typically, are not taught how to apply/use it, which is why transfer does not occur. If one does not know how to apply/use it in a real world scenario, what purpose does it serve? It is like an empty vessel. It is simply an object/idea with no significance, but perhaps awaiting rediscovery, like an uncovered archeological object that stumps scientists' understanding of its use.

So the purpose of education – the ability to use inductive steps in applying knowledge or for use in discovery – is lost to the worship of *authority* and the disregard of retracing footsteps of discoveries beyond the referenced *authority's* conclusions. That is, the *ends* are the only important accomplishments while the *means* have no significance, yet it was the *means* that brought about the *ends*, so how can this be unimportant? It's treating the

[7] To be fair, classical studies were abandoned in large part due to the focus on Latin and Greek languages. Rather than teach about the lessons to be learned from the past, many educators focused on these languages almost exclusively and put their faith in students' ability to discern such lessons simply by reading the classics in their original languages since they were so rich in nuances that are absent from English in large part. This is another example of educators believing in transfer occurring naturally without any guidance.

means as simply the accidents of history that were stumbled upon by chance, but with no lessons to offer in the hopes of future discoveries. While *ends* are certainly important to society, teaching the *means* is more important to students since it is through the understanding of *means* that innovation, adaptation, and invention are manifest. This is extremely important to the progress of society; otherwise people may become more akin to computers where they are able to regurgitate facts when commanded, but will be unable to innovate due to their incapacities to reason.

Besides using historic examples of the process of inductive reasoning, an example of how inductive reasoning of truths can be taught might be the use of suspense stories or thrillers. Suspenseful stories can captivate an audience and when the truth has been discovered by the audience, strong emotions of gratification are produced (Doyle's Sherlock Holmes stories were very popular for this reason) and it is well known that strong emotions attached to an experience or the acquisition of knowledge tends to fuse it to the memory.

Incorporating deductive reasoning where appropriate in education and using historical examples of how inductive reasoning was used for discoveries, should provide a rich base for curricular materials to help provide the development of the mental faculties in students so that transfer of learning becomes a commonplace rather than the rare exception as we have it today.

* * *

Haskell points out how important it is for citizens to reason in a free society and the absence of it by and large:

> The implications of this general failure are serious not only for a society increasingly dependent on what is called "knowledge workers," as opposed to skilled workers, but for the democratic process as well. The Founding Fathers of the U.S. Constitution understood that for a democracy[8] to work well, an informed populace is required; the term *informed* includes the ability to think and reason well. Transfer of learning underlies the ability to think, reason, plan, and to make good decisions. … (pp. xiii-xv)
>
> The very definition of transfer – applying what we have learned in the past to understanding and grasping the present – is learning from history, both individually and culturally. Learning from history, then, is the very exemplar of transfer.
>
> … Unfortunately, we do not generally learn from history. To cite the well-worn words of the philosopher George Santayana (1863-1952): "Those who cannot remember the past are condemned to repeat it." … In terms of transfer, the only thing we learn from history is that we don't often learn from it. (pp. 75-76)

[8] We need to clarify that ours is not a "democracy," but rather is a republic. Greece of antiquity was a democracy and it failed miserably.

Perhaps an interesting twist on the subject of history is to teach the historical perspective for each subject in school. In other words, we should consider including the teaching of science, technology, language, math, etc. from a historical perspective. Understanding the evolution of any subject, rather than the raw data that gives it form, allows for knowledge to sink deeper into one's psyche, thereby providing the mechanism for transfer.

Let's consider the American Founders and their command of the past and how effective they were in reasoning and therefore capable of establishing the best form of government yet devised. They were taught to reason through classical studies of antiquity, humanism of the Renaissance, and Natural Law philosophy of the Enlightenment; the latter frequently referred to as the Age of Reason. Natural Law was based on reason; that is, to understand the good, the bad, or the neutral outcomes of societal or individual actions, one must observe the effects of such actions. The consequences of those actions reveal, in general, the value of those actions. I think Will (2015) expresses this concept perfectly when he states, "… freedom of speech, by which truth is winnowed from error, is most reliably defended by those in whose intellectual pursuits the truth is most rigorously tested by reality."

For the sake of simplicity, let's consider the consumption of liquor as an analogy to demonstrate the Natural Law idea of discovering truth: Is consuming liquor good or bad for adults? In moderation, it is fairly well accepted in medical circles to be beneficial to one's health. However, if taken in excess, it is detrimental. The same is true of many things we do. Moderation then has come to be understood as *a rule of thumb* for general human activities when concrete understandings are not available. However, there are those things we know are bad and we make laws to prevent them, such as theft, rape, murder, etc. Even doing them once is intolerable. These issues are more readily discernable and provide good analogies to make a point between the obvious and less obvious about fundamental reasoning. We can correlate the obvious to near transfer and we can correlate the less obvious to far transfer.

Another analogy for far transfer might be the political debate over expanding Federal power or shrinking it. Expanding it allows for certain sectors to assert their will using the argument – amongst others – that local democratic forces prevent local lawmakers from making the "right choices" for citizens. It is therefore asserted, these lawmakers' constituents simply won't allow them to do the "right thing." However, once power is centralized, it takes Herculean effort to disperse it again. What happens when the "wrong group" gains power? Won't they make the "wrong decisions" and work toward furthering the centralization of power to the detriment of those who initiated the centralizing movement?[9] Also, as power becomes centralized, resources, such as tax revenue and military might, become centralized. This means it will be accessible to a smaller group of people who can easily assemble special interests and divvy up the wealth and power as long as they can disguise their intent under such dictums as Jeremy Bentham's: *The*

[9] Think of late 19th century Germany under Chancellor Bismarck and how extensively he centralized national authority. (Americans imported Bismarck's concepts through the Progressive movement.) There is a direct lineage from Bismarck's centralizing concepts to Hitler's abuse of them.

greatest good for the greatest number of people.[10] Corruption and the abuse of power are the end results but now on a massive national scale.

Such outcomes of social actions are not easily discerned by most because we are not taught in the public education system to look at the whole picture in order to consider the full ramifications of our decisions and actions. However, this is exactly what is required in the political and economic realms if we hope to continue to be successful as a country. The Founding Fathers understood this only too well; hence the reason they pushed for citizens to be educated based on the then contemporaneous understanding of what education entailed – the teaching of reason after a literate foundation has been laid. This is what far transfer is all about, which our schools do not address, and which we are in very short supply of amongst our citizens from which to draw wise and competent politicians and leaders – consequently the degradation of our society.

Similar types of examples can be provided as it relates to economic understanding and decision-making processes in our country. Many people foolishly believe in socialistic principles because they lack a proper education and possibly even reasoning abilities. They do not comprehend how dangerous such systems are because they do not understand human nature sufficiently[11] to know that such systems lead to the same centralizing tendencies mentioned above that expose nations to dangerous coalitions that will inevitably form and then implant dictators like Hitler, Mussolini, Stalin, and Mao in power.

In addition, technical know-how has similar challenges. Those who pass through the halls of academia who were focused on the "pure sciences," in contrast to the applied sciences, are frequently incompetent in the real working world. Their concepts and designs require a great deal of interpretation, intervention, and redesigning by those who do know how things are made. Whether we are considering chemists or physicists, technicians must make significant corrections to the ideas of "pure" scientists. There is a significant chasm between "pure" and applied sciences because the "pure" sciences are not taught for application. Rather they seek to continue the process of dissecting phenomena as their predecessors had done with little thought of joining concepts together to better understand the interrelations that make the universe function. As a matter of fact, within scientific circles, there is a cultural taboo that prohibits scientists from crossing into territory outside their expertise. They protect their own turf and ostracize those not of their "tribe" who attempt to enter their territory. This cultural taboo contributes significantly to the educational field steering away from transfer of learning because without a commanding view of the big picture, transfer is inhibited.

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[10] The Nazis, which the majority of Germans did not fully identify with, used this kind of argument as it applied to the German people; demonstrating the truth of Edmund Burke's maxim, "All that is necessary for the triumph of evil is for good men to do nothing."

[11] Consider the experiments of Robert Owen (1771–1858) and the American Pilgrims. Owen started a socialist experiment in New Harmony, Indiana. Within a year, he discovered that mankind was not morally evolved enough for socialism to function, just as the American Pilgrims discovered when they experimented with a socialist type system when first settling on this continent (see https://mises.org/library/great-thanksgiving-hoax-1). The Pilgrim's and Owen's conclusions still hold true today.

Perhaps Detterman's analysis of college graduates' and professors' lack of abilities in transfer helps explain this situation.

> [T]he failure of transfer isn't confined to students. "To my knowledge," he says, "there is no convincing body of evidence showing college professors, to say nothing of college graduates, regularly applying old learning to new, novel situations." In short, says Detterman, "We replay most of our behavior exactly as we learn it." (Haskell, p. 42)

Getting to the Root of Transfer

Haskell addresses the deficiency of understanding of transfer by stating, "The failures in transfer of learning and the lack of development in the field are in large measure due to a lack of an adequate theoretical base." (xvii)

Haskell explains an important evolutionary issue: Mankind is not hardwired for the current technological conditions he must operate in.

> The human brain has evolved over millions of years. During most of this time, the environment has not demanded of our brain what our modern Information Age demands. At no time in history have we been required to process the amount of new information that we do today. We process this information with a brain that has not yet sufficiently evolved to cope with the modern demands of the Information Age. The brain is an old and wise organ that has its own evolutionary reasons for functioning the way it does. The last evolutionary update was probably over a hundred thousand years ago. There's thus an evolutionary lag between the development of our brain and our current need to process large amounts of information. For the most part we have an ancient brain trying to function in a Space Age. Transfer of learning is a way to shorten this evolutionary lag. (pp. 7-8)

Disconnected raw data, that is typically offered as the means of instruction, doesn't make the grade. Haskell states:

> … I would like to note that just having a knowledge base is not enough. Information by itself does little; it needs to be entered into a prepared cognitive system. Knowledge often consists of a mass of rotely memorized subject matter that's not understood deeply enough to enable a student to think critically about a subject. There are situations, too, where an extremely knowledgeable person can be so well informed about an area that he becomes inflexible and is not able to conceive or to consider alternatives. … Think about it for a moment: if simply entering knowledge into our mental apparatus was sufficient, people who have photographic memories would be brilliant and creative. They're not. At least not any more than the rest of us. (p. 98)

Without the ability to transfer, people have great difficulty in adapting, innovating, and developing new technology and economic opportunities, which is something 19th century Americans were famous for in a period when **very** few had a high school or college degree. There appears to be a direct correlation between increased levels of education in our country during the 20th century and a decline in economic prowess, a loss of liberty, and moral degradation. If our educational system does indeed inhibit transfer, then the ability of the American people to innovate will suffer and economic progress will stagnate. Personally, I have observed this time and again in the business world. The inability of most American companies to adapt to changing conditions is rampant.

As Murray and Herrnstein point out in *The Bell Curve* (1994), in an attempt to reengineer society, those who were and are in positions of political power and influence in the U.S., establish laws and regulations that are exceedingly complex, making it extremely difficult to navigate through the legal and economic systems in all walks of life without hitting landmines. They point out that the average person can no longer know right from wrong given our regulatory Leviathan. The complexity of our legal system, like the complexity of an economic system, is beyond any individual or group of people to fully comprehend and therefore lack sufficient understanding to perceive the overarching negative ramifications of the application of all these laws and regulations. The human brain is simply not capable of seeing such a vast landscape of social interaction. Adam Smith in his *Wealth of Nations* spoke of the *invisible hand*[12] that steers a free economy since no one can actually perceive the complexity of it. The same is true of a complex political/legal system as explained by Thomas Paine[13] in his work that helped inspire American independence, *Common Sense* (1776). He stated:

> Absolute governments, (tho' the disgrace of human nature) have this advantage with them, they are simple; if the people suffer, they know the head from which their suffering springs; know likewise the remedy; and are not bewildered by a variety of causes and cures. But the constitution of England is so exceedingly complex, that the nation may suffer for years together without being able to discover in which part the fault lies; some will say in one and some in another, and every political physician will advise a different medicine.

Murray & Herrnstein, Smith, and Paine show how complex the world is and how it is beyond anyone or group of people to fully comprehend. Therefore, what a general education effort must aim for is broad foundational principles that technical, economic, and political/legal systems rest upon since complex, massive societal interactions in their minute details cannot be tied together within the human mind, though fundamental principles can. With such foundational interconnected understanding, details of individual systems are more readily comprehended as one may delve into them as needed.

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[12] "In economics, the **invisible hand** is a metaphor used by Adam Smith to describe unintended social benefits resulting from individual actions." Wikipedia

[13] Paine, along with many of his generation, demonstrated outstanding far transfer abilities due to the education of the Enlightenment period. This is something sorely lacking today.

The Lack of Transfer Can Be Summarized

Currently, our public education system ignores foundational principles and focuses on the details of each subject taught in school; that is, they take dissected pieces of data from the various subjects, like pieces of a puzzle, offering the pieces as transferable knowledge, rather than assembling the puzzle pieces so that the image can be discerned. Individuals attempt to memorize such disconnected detailed pieces in preparation for tests, and then forget what they memorized once tests are behind them. As Haskell points out "what the majority of studies show isn't a failure of students to achieve transfer of learning but something worse: a failure of learning itself." (p. 16) Haskell cites Howard Gardner's book *The Unschooled Mind* (1991) to point out that even "students who receive honor grades in college-level physics courses are frequently unable to solve basic problems and questions encountered in a form slightly different from that on which they have been formally instructed and tested." (p. 15) This demonstrates that tests do not measure intelligence but simply memory and recall-ability. Haskell says, "I can't stress enough the evidence demonstrating the wholesale failure of transfer in most instructional situations. Without exaggeration, it's an educational scandal." (p. 16)

Spencer (1860) provides an example how this can occur:

> The rote-system, like other systems of its age, made more of the forms and symbols than of the things symbolized. To repeat the words correctly was everything; to understand their meaning nothing: and thus the spirit was sacrificed to the letter. (p. 102)

Spencer then displays his understanding of transfer of learning:

> Between a mind of rules and a mind of principles, there exists a difference such as that between a confused heap of materials, and the same materials organized into a complete whole, with all its parts bound together. … The union of facts into generalizations *is* the organization of knowledge…. (p. 103)

Mestre compares reasoning abilities to memory abilities showing how they are decoupled:

> **[O]ne consistent finding is that reasoning accuracy is independent of memory accuracy across a broad range of problems: Memory for problem facts was found to be unrelated to reasoning about those same facts. This finding contradicts theories that rely on assumptions of limited working memory as an explanatory construct in reasoning and problem solving. (p. 54) … Under certain circumstances, factors that enhance verbatim memory [memory for surface details] actually depress reasoning performance**. (p. 55) (Emphasis added)

This flies in the face of everything academic today! The educational community believes that memory and reasoning go hand in hand and assessment tests, which are correlated with high stakes outcomes, reflect this belief. Indeed it is a belief, not a truth, with

devastating consequences to those who may have outstanding reasoning abilities, but who lack outstanding memory abilities. The harm done to individuals and society is inestimable!

The National Academies of Sciences (2018) reinforces Mestre's conclusions:

> Most learning experiences involve multiple types of learning, not just one. For example, collaborative learning and problem solving in teams would engender learning by observation, feedback, facts, rules, and models, as well as possibly other types of learning. At the same time, research supports the principle that different situations and pedagogical strategies promote different types of learning. Before a teacher or learner can design an ideal learning situation, she has to decide what kind of learning she is trying to achieve. For example, one generalization that has emerged from decades of research is that promoting memory for specific facts requires different learning experiences than promoting knowledge that is transferable to new situation [sic]. Techniques focused on improving memory include spacing practice over time, rather than massing all practice at a single time; practicing retrieval of memorized information, rather than just studying the information again; and exposing learners to materials in different settings. By contrast, techniques focused on promoting transfer to new situations include comparing and contrasting multiple instances of concepts; having students reflect on why a phenomenon is or is not found; and spending time developing powerful models, rather than asking learners to simply repeat back what they are told. (p. 55)

If foundational concepts were offered to students that provide overarching ideas, rather than disconnected detailed data that are memorized for tests, everyone would more readily realize transfer. Literacy and numeracy would improve dramatically. There may be those in the academy who bemoan the loss of the ability to rank students since outcomes across populations might actually experience a leveling effect. However, in the place of a ranking system that seeks to marginalize a majority of citizens, assessment methodologies could be used to discover talents in order to steer each individual in a direction that affords social success in its various manifestations.

To use an analogy that gets Mestre's point across, let's move the thought to a physical domain – the ability to fight to defend oneself or one's country. Many believe that a big strong weightlifter is bound to win any physical contest in the fighting arts – but they'd be wrong. An individual who studies the fighting arts, who does not even lift weights and does not have large muscles, is more often than not going to be the victor in such a contest. This is because brute strength, as seen in large muscles, is unnecessary and frequently a detriment to the use of one's body in the arena of fighting. As a master of Hapkido, I am fully cognizant of this truth. This correlates with a comparison of the study of an academic program versus a CTE program. The academic student is like the weightlifter, repeating motions over and over but with no real-world application in mind; whereas the CTE student is refining himself with useful skills in mind. The exclusive pursuit of academic studies dulls real-world abilities while CTE enhances them.

There is one more comparison to make between weightlifting and the pursuit of "academic rigor": They both tend to engender vanity – a most unbecoming human attribute.

Haskell points out that even the buzzwords of education – e.g. "critical thinking," "problem solving," etc. – don't accomplish what the terms imply.[14] He makes the following points to clarify his thoughts:

> [T]ransfer figures prominently in the "new wave" of interest in instruction of critical thinking. Early in the critical thinking movement in education, it was noted that "transfer is integrally involved in teaching critical thinking and problem solving." Says Wilbert McKeachie, "When faculty members talk about teaching critical thinking, problem solving, or reasoning, they typically are referring to teaching students to use their learning in new situations to solve problems."[15] (p. 11)
>
> Having now established the importance of transfer, it's equally important to look at our failure to achieve it. Because the failures are so profound, and lest readers think I am exaggerating and overstating the case, I will again let researchers and practitioners speak for themselves. (p. 12)
>
> In teaching problem solving, one recent report entitled, "On the Limited Evidence for the Effectiveness of Teaching General Problem-Solving Strategies," the author concludes, "There is very little evidence of successfully teaching general problem-solving techniques in mathematics education." Another researcher concludes, "There is relatively little empirical evidence concerning transfer of formal problem-solving procedures." Yet another observes that the effectiveness of problem-solving programs appears to be "limited to near transfer situations where the test problems are similar to those encountered during training. Evidence for far transfer is generally lacking." … (p. 13)
>
> During the early years of life, children learn and transfer at an incredibly rapid rate in their natural, everyday setting. … When formal schooling begins, however,

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[14] Haskell (p. 23) quotes Wilbert McKeachie, (*Teaching and Learning in the College Classroom*, 1986) offering another angle to look at transfer, "We talk about 'transfer of learning' when … learning is displayed in a situation somewhat different from that in which the original learning occurred. If the transfer situation is so different that the use of learning encounters some barrier or difficulty, we speak of 'problem solving.' When the situation is greatly different and the distance of transfer needed is greater still, we speak of creativity."

[15] Bauer-Wolf (2018) cites Busteed of Gallup who provides that "generally an employer believes that 'critical thinking' is coming up with new, original thought. But in an academic sense, it can mean more picking apart ideas in depth." Both of these definitions are wrong. The first defines creativity and innovation while the second merely signifies dissection of something. Critical thinking is the ability to see issues from multiple angles based on transfer of learning abilities. That is: If one thing is "this" then it can lead to "that." Understanding cause and effect is another way to define critical thinking.

> little significant transfer occurs from instruction. The question is, What's going on here – or, rather, what's not going on?[16] (pp. 47-48)
>
> As the teaching of problem solving goes, so goes the teaching of learning strategies. As one researcher notes, "Many of the learning strategies programs have nonempirical foundations, provide relatively superficial strategy training (usually only a subset of the essential learning concepts), are evaluated against nonspecific criteria (such as grade-point average), and consequently, lack specific evidence on which to base modifications." (p. 13)

Haskell lists the failures noted by additional researchers, revealing the seriousness of the situation. All of this calls into question the justification of a compulsory system and in particular, one run by government bureaucracies that prove their incompetence time and again. The failures are so deep and widespread, one must ask, how much worse can it get and isn't there an alternative to the centralized bureaucratic system? The idea of everyone being literate is an extremely important one, but the idea that it can only be achieved through a government bureaucratic dictatorship is where the destructive flaw can be identified as the source of the disease that has evaded a cure for well over a century.

The Spirit of Transfer

The spirit of transfer is a concept Haskell uses to explain how transfer is extracted from the hearts and minds of students. He defines *the spirit of transfer* as

> [A] psychological, emotional, and motivational disposition toward deep learning.
>
> … Carl Brell recognizes that "… transfer … calls attention to the fact that teaching for transfer is less a matter of transmitting knowledge, skills, strategies, and principles of thinking (though it is that, too) than it is of fostering in students from the start an inquiring disposition…." (p. 117)
>
> A spirit for transfer infuses information with meaning; for it's meaning that transforms *information* into *transferable knowledge*. (p. 118)

This is reflected in the words of Montaigne (1580) where he makes this analogy of a bee turning pollen into honey:

> Bees cull their several sweets from this flower and that blossom, here and there where they find them, but themselves afterwards make the honey, which is all and purely their own … so the several fragments he borrows from others, [the student] will transform and shuffle together to compile a work that shall be absolutely his own….

[16] The difference is this: A child in its early years is learning in an applied realm; whereas school does not teach in this realm, hence its failure in achieving learning and transfer.

Individual personality traits may determine student's abilities to acquire and use knowledge far more than what has previously been understood. If this is true, and I believe it is, then, Charles Darwin's words reveal an unforgiveable injustice we have been perpetrating upon our citizenry: "If the misery of our poor be caused not by the laws of nature, but by our institutions, great is our sin."[17] Haskell reveals our errors and therefore the want for our atonement.

> I suggest that significant and general transfer is primarily the consequence of personality and other dispositional characteristics such as attitude, motivation, and feeling. In short, I … suggest that general transfer is the consequence of what I refer to as the spirit of transfer, not simply – nor even significantly – to educational methods, learner strategies, or teaching techniques. … (p. 116)
>
> Ronald Wideman and Herbert Owston lamented, "The fragmented information and skills that students are supposed to master are often lacking in enough personal meaning to lead students to make the cognitive efforts necessary to learn and develop."[18]
>
> The fact is, the more meaning that learning has for us, the more complex are our conceptualizations. In turn, the deeper our understanding, the greater are our transfer possibilities. … Meaning, then, consists in the number of internal connections a piece of information has in our existing knowledge base. (p. 123)
>
> Whatever the specific mechanisms are, it seems clear that feelings influence the cognitive processes responsible for transfer.
>
> In *Learning in Medical School: A Model for the Clinical Professions*, John Biggs points out that most everyday learning derives from a felt need to learn what is important at the time. (pp. 124-25)
>
> Virtually all contemporary discussion on instruction and transfer concerns techniques, strategies, skills, and methods of instruction. … Although instructional technologies are important, from my years of teaching experience and my review of the significant transfer research, I have become convinced that without the transfer "spirit," there is precious little transfer. … [T]ransfer research shows that whatever transfer may be generated by technique, strategy, and method is typically the lowest level of transfer. (p. 116)

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[17] I think this dispels once and for all the Progressives' propaganda attacks on *laissez-faire* as "Social Darwinism" as it relates to a free society. The true location for the theory of "Social Darwinism" can be found in the halls of academia and on the fields of college sports.

[18] This is something that appears to be entirely overlooked by the education establishment but which is so important to so many students! The lack of this understanding by educators is **the** primary force that drives so many high schoolers to leave school. How do educators respond to this? By ostracizing those who quit rather than blaming themselves for driving students out of schools. To add insult to injury, the educational establishment then makes it next to impossible to acquire credentials by barring entrance into other educational avenues if a high school degree is not in hand. This is evil of the highest order and is a major contributor to minority marginalization.

There are personality characteristics that effect transfer as Haskell points out: "[T]raits like persistence, locus and control, confidence, anxiety, fear of failure, other emotional issues have also been found to influence learning and transfer." (p. 121) However, poor teaching strategies will frequently lead individuals to be overwhelmed by these negative traits. Haskell cites the work of Daniel Goleman to solidify this understanding of human dynamics:

> Building on Howard Gardner's theory of multiple intelligences, and the neurological findings of Joseph LeDoux, Goleman shows how harnessing our emotions can lead to success, even if we don't possess an especially high level of intelligence; conversely, studies show clearly that possessing a high I.Q. does not guarantee us success either in our personal lives or in our business affairs. (p. 123)

This demonstrates that our culture misinterprets what "intelligence" means. What is being measured when we speak of "intelligence" in mainstream circles are memory retention and data recall abilities, but not reasoning or transfer abilities. This is why high I.Q., SAT, and ACT scores do not directly reflect success – only indirectly since one must pass through the halls of academia to be allowed access to lucrative credentials. Therefore, high scores do improve one's chances of success due to the educational establishment's hijacking of the political/economic system through accreditation and credentialing monopolization. Remove their power and control and we would see very different outcomes as it relates to success.

There are those in cognitive psychology circles who believe intelligence can actually be improved. This is based on the perspective that "paper and pencil" assessment tests define intelligence. In essence this is saying: If I take a test today and get 75% of the answers right, I am of "average intelligence"; but if I retake the test with revised questions and get 100% of the questions correct, suddenly my intelligence is dramatically improved! But what if the reason for the first test results were due to an ineffective teacher and/or a poorly designed curriculum? And what if the reason for the second test results were due to an excellent teacher and excellent curriculum? Can we honestly say that I was previously "dumb" but suddenly and magically became "brilliant"? I think this example sufficiently dispels the concept that intelligence can be improved.

Perhaps Haskell's view on personality traits influencing learning and transfer might help explain a lack of understanding of the concept of "intelligence" that is revealed through the differences between economic outcomes of those with a high school degree versus those who acquired their GED versus non-completers. That is, while the academic abilities of high school completers versus GED recipients are very similar, research shows that the economic outcomes between these two cohorts is different; as is the difference between non-completers and these two cohorts. (See Heckman and LaFontaine, 2005) Even if individuals in all three cohorts were to have identical academic abilities, their economic outcomes would, on average, differ substantially due to non-cognitive attributes such as motivation and endurance.

It is my opinion that the differences in economic outcomes between these three cohorts have far more to do with personality traits as Haskell, Gardner, and Goleman emphasize than with their ability to memorize and recall data. Our culture's fixation on credentials, **far more** than on real knowledge and real world economic abilities, supports the educational establishment's unjust and prejudicial system. Therefore, those whose personality traits proved to be barriers in achieving some sort of credential through the bureaucratically controlled, highly optimized public education system, are marginalized in our society simply for not fitting the educational establishment's mold. Those of the marginalized sector are therefore relegated to sub-citizen status that politicians prey upon by promising the extraction of wealth from some in exchange for votes. We can then conclude that the public education system perpetuates a lower socioeconomic class through this highly optimized, antisocial marginalization process, and it helps perpetuate the divide and conquer mentality commonly used by many politicians.

In his conclusion, Haskell discusses the problem with changing the educational system. The problem is, there is great resistance to change from all sides.

> There is a "kicker" involved in deep-context teaching that I haven't yet mentioned. The kicker is us teachers. To one degree or another, many of us are afflicted with the same erroneous knowledge base, expectations, and cultural values that impact upon subject matter and learning. We are a part of, and subject to, many of the same forces that impact our students. Thus, trying to change the deep context of teaching and learning is somewhat like trying to build a boat in midocean. Somehow we need to create a dry dock in this ocean of countercontexts. The problem is that many of the educational institutions, as well as the culture at large, mitigate against change. We need to deal with this context on both a personal and a professional level. (p. 227)

Change must come from the outside. Humans resist change instinctively. Therefore, the education establishment, if left to its own devises, will allow for incremental changes only, but it can never keep up with an ever-changing dynamic world. The reaction time to change of a large institution is far too slow. Therefore, citizens and business leaders must band together to pressure politicians to decentralize and deregulate education, leaving it up to individuals and communities to manage their own affairs. Change must be forced upon the education community since those within it will inevitably resist any change that takes them out of their comfort zone.

Transfer and the Real World

Lave (1988) opens her work with "It seems impossible to analyze education … without considering its relations with the world for which it ostensibly prepares people." (p. xiii) She challenged previously held assumptions that our public education institutions teach for transfer across situations. (p. xiv) "When the project began in 1978, we were notably ignorant about the occurrence, organization and results of arithmetic practice in everyday situations." (Lave, p. 47) "We tried … to obtain a sense of how much and in what ways participants used math on the job. The settings – kitchen, Weight Watchers meetings,

supermarkets – required description and analysis." (p. 49) "Next came a series of sessions exploring school-taught math procedures: a multiple choice test and a series of pencil-and-paper math problems, number and measurement facts, mental math problems and finally calculator problems. … [W]e knew so little about everyday cognitive activities…." (p. 50)

Lave discovered an

> urgent … need to find a theoretical framework that would account for the specifically situated structuring of cognitive activity, including mathematical activity, in different contexts. The Adult Math Project [AMP] was born of these concerns. It was designed to investigate arithmetic use *in situ* [*where it occurs*], following the same individuals across varied settings in the course of their daily lives. (p. xiv)

> How does arithmetic unfold in action in everyday settings? … Are there differences in arithmetic procedures between situations in school (e.g. taking a math test) and situations far removed from school scenarios (in the kitchen or supermarket)? (p. 2)

> The research focused on adults in situations not customarily considered part of the academic hinterland, for no one took cooking and shopping to be school subjects or considered them relevant to educational credentials or professional success. … Is the absence of school-problem formations in everyday math activity to be interpreted as "the absence of school mathematics," the construction of some other mathematics, the inadequate or incomplete use of school arithmetic? How does schooling shape arithmetic activity in everyday situations? What model might best capture the unfolding character of problem-solving processes *in situ*? What constitutes an adequate, general theoretical formulation of situationally specific cognitive activity, of mundane settings, and of activity in such settings? (p. 3)

On pages 4 and 5, Lave introduces the reader to the culture of education and the relations between scientists (educational psychologists), educators in general, the school experience, alumni, and laymen (a hierarchical ordering akin to aristocratic cultures). She points out that this web of relations shapes and perpetuates this culture's social construct. However, this culture is not critical of itself in any self-reflective manner. It plods along year after year but without a map, rudder, and compass. It has a perpetual force that resists any change in direction, other than, perhaps, very subtle ones that do not upset the apple cart too much. She states:

> At the center of this cultural web lies the concept of learning transfer, reflecting widely shared assumptions about the cognitive basis of continuity of activity across settings. Conventional academic and folk theory assumes that arithmetic is learned in school in the normative fashion in which it is taught, and is then literally carried away from school to be applied at will in any situation that calls

> for calculation. … The most common view distinguishes successful alumni from the unsuccessful, attributing constant and skilled use of school knowledge to the former, and rare, often erroneous, use to the latter. None of these propositions is given support by AMP research. (p. 4)
>
> The participants of the AMP inhabit a world conventionally presumed to be populated by faulty mathematicians – a world in which the importance and ubiquity of math has not been assessed but is never questioned. (p. 6)
>
> It is puzzling that learning transfer [theory] has lasted for so long as a key conceptual bridge without critical challenge. The lack of stable, robust results in learning transfer experiments as well as accumulating evidence from cross-situational research on everyday practice, raises a number of questions about the assumptions on which transfer theory is based – the nature of cognitive "skills," the "contexts" of problem-solving and "out of context" learning, the normative sources of models of good thinking and less than perfect "performances." Transfer theory may well owe its longevity to its central location in the web of relations discussed above, institutionalized in divisions between the disciplines of anthropology and psychology, in schooling, and in dichotomies between scientific and everyday thought. Basic and profoundly embedded assumptions govern the persistent loyalty to transfer [theory] and all that it stands for, and a strong break with this tradition, though costly in theoretical consensus, is a promising means for moving the study of cognition into the larger social world. (p. 19)

Those who choose not to complete high school are typically those who challenge the system and when the system cannot answer their challenges, they "dropout." Society perceives these individuals as the "losers," but are they? Perhaps many of them are far more intelligent than they are given credit for. After all, they were smart enough to perceive the lack of utility in what was being taught; they were smart enough to perceive the school's curricula as simply wasting their precious time that could be used to more productive ends; and they were smart enough to withdraw their resources (i.e. their time) from an investment that would give them negative returns (the average statistics used that contradict this statement are far to broad to have any significance for individuals to base conclusions or decisions on – one must dig deeper into data and measure more qualitative aspects). If our culture was not so prejudicial toward this sector, we may very well see many more innovative and entrepreneurial individuals arise from this population. We could see inner city drug dealers as an example of very intelligent businessmen who found a way around the credentialing establishment that bars entry to economic opportunity other than through its highly guarded and government protected "approved system."

Lave (p. 42) analyzes what motivates individuals to take decoupled-from-reality tests that provide no apparent real world returns. And on page 43, she discusses the de-contextualization of the type of problem solving that is learned in the school setting from context-rich problem solving in socially situated activities, i.e. the real world.

Some AMP results:

> [Y]ears of schooling is a good predictor of performance on the arithmetic tests, as are age and years since schooling was completed, though in the opposite direction (e.g. the more time passed, the lower the score). … There is a large disparity in success between the arithmetic test performance … and those in supermarket and best-buy experiment…. [S]uccess and frequency of calculation in supermarket and simulation experiment bear no statistical relationship with schooling, years since schooling was completed, or age. (pp. 55-57)

> A narrow focus on transfer [in a school-like setting] is not equivalent to, nor representative of, the experience of bringing knowledge to bear in diverse situations in the lived-in world. (p. 62)

Lave then cites other math type studies done comparing the schooling world to the real world. She states: "All of these studies show consistent discontinuities between individuals' performances in work situations and in school-like testing ones." (p. 66)

In citing a particular experiment, Lave provides revealing information about what most people believe to be a given:

> There is evidence that workers made calculations which were arithmetically more advanced than they had the opportunity to learn in school. "Although this blue-collar group's average educational level was 9th grade, some of the men had not completed elementary school. However, on the average, their knowledge of math facts and ability to do mental and written math with whole numbers and negative numbers were on a par with students who were above the 9th grade level in math achievement." They were also more flexible in choosing strategies for solving problems: "workers demonstrate marked superiority over students in their use of flexible strategies…." (p. 67)

The flexibility of those with less education demonstrates that current formal education settings tend to develop the mind into thinking within a box. From this, we can see that middle school should be a time of transition and that students in this age group are ripe to learn many different things that are not on the menu in most secondary schools.

One of the researchers Lave cites "recommends caution about the predictive value of school testing for success in the workplace…." She then offers, "AMP findings concur."

She (pp. 87-92) informs us that everyday people and everyday work is considered primitive or lowly by many social scientists and not worthy of study. This perspective then radiates to the larger academic community, if not directly, then certainly indirectly. It then becomes clear that the common man, who is despised by academic types, cannot look to the educational establishment for assistance in preparation for life, but must find alternative methods that will provide the necessary development.

This helps explain why those in lower socioeconomic sectors are provided insufficient attention. Politicians and academics have, for the most part, taken the stance that throwing more money at this sector will cure social problems, but since the 1960s, there has been a steady increase in educational investment, yet the gulf between the "haves" and "have-nots" has not improved.[19] Obviously politicians and academics are missing the boat; hence the reason businesses and citizens must combine their energies to take charge and make the changes themselves. As Reagan candidly declared, "Government is not the solution to our problem; government is the problem." There is no greater evidence of this than in our educational establishment.

Mental Disciplinarians

Kliebard discusses a movement of the late 19th and early 20th centuries that dominated education for a time, and which is still present to this day. It has been completely absorbed in the educational community without the awareness of its existence by many.

> The curriculum status quo in the 1890s was represented by the doctrine of mental discipline and its adherents.[20] … Mental disciplinarians built on that psychological theory by alleging that certain subjects of study had the power to strengthen faculties such as memory, reasoning, will, and imagination. … Just as the muscles of the body could be strengthened through vigorous exercise, so the mental muscles, the faculties, could be trained through properly conceived mental gymnastics. … Moreover, the range of faculties presented a basis for defining the scope of the curriculum. Since neglect of any faculty meant atrophy of that mental muscle, it became incumbent on educators to see to it that no imbalances were created in the curriculum by emphasizing subjects that developed certain faculties and not others. An ideal education meant all-around mental fitness, not just the development of one or two mental muscles. (p. 4)

There is truth in this, but the types of exercises one practices make all the difference. Memorization for tests is analogous to weight lifting; it makes you stronger but to what end? Is it strictly for health or to some larger purpose such as health and the mastery of one's body? Weight lifting may benefit health, but not mastery of the body such as one may accomplish through gymnastics, dance, and martial arts. The analogy is true of mental discipline exercises: The mind may be active and can stay focused for extended periods of time, but there is no mastery of the mind for useful ends – whether abstract or applied. It is simply conditioned for memorization and recall of raw data, and perhaps some very basic logic that educators like to assign fancy titles to – such as the term "critical thinking," "problem solving," and other similar attributes – in order to give the impression they are making progress.

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[19] Like **his** war on North Vietnam, Johnson's War on Poverty – as part of his "Great Society" socialistic agenda – was a complete failure.

[20] Its adherents followed the German psychologist Christian Wolff, 1740.

Another way to look at it is revealed in the dilemma tool collectors sometimes face. The Mid-West Tool Collectors Association provides a webpage for its members to post pictures of antique tools they cannot identify. They want to know what the tool was used for and need help from others in identifying its purpose.[21] Much of what passes for "education" has similar attributes: People may possess many mental "tools" the educational system crammed into their brains, but they cannot identify their purpose and therefore are at a loss as to their function and usefulness.[22] Therefore, many college graduates enter the economic realm utterly ill prepared for the real world (not to mention the political brainwashing they experienced that taught many to hate the Western tradition). Gallup has laid bare the vote of no confidence by business leaders and the public at-large regarding the effectiveness of postsecondary education.[23]

Lave touches on the mental discipline movement:

> Learning-transfer research had its beginnings in Thorndike's critique of the doctrine of formal discipline. Any form of mental discipline was supposed to improve the minds of school pupils in a general way. This rationale, a popular defense for Latin instruction in the early 1900s, is still heard in the 1980s in defense of geometry, other branches of mathematics – and Latin. In functionalist psychological theory, mind and its contents have been treated rather like a well-filled toolbox. Knowledge is conceived as a set of tools stored in memory, carried around by individuals who take the tools (e.g. "foolproof" arithmetic algorithms) out and use them, the more often and appropriately the better, after which they are stowed away again without change at any time during the process. The metaphor is especially apt given that tools are designed to resist change or destruction through the conditions of their use. (p. 24)

Regarding Lave's reference to the "doctrine of formal discipline": One may see this as a convenient rationalization to justify a method of instruction that does not tax the abilities of instructors. If the instructor does not comprehend the deeper and broader significance of a discipline that can be applied to the real world, then simply teaching insignificant raw data – or at least disengaged information that cannot be used or transferred as presented – is something that most anyone can do who has a shallow understanding of the discipline. True/false and multiple-choice tests support and perpetuate this shallow system that rewards memorization talents but punishes those who question and challenge the significance of what is being taught to them – i.e. critical thinkers.

While the monotonous elements may be marginalized for the most part, there are still elements of the mental discipline perspective persisting as it relates to "the range of

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[21] http://www.mwtca.org/whats-it.html

[22] See *Stanford Physicist Embarks On Mission To Improve Undergraduate Teaching* to get an idea of what one professor, Carl Wieman, is doing to rectify this problem: http://www.npr.org/2016/04/13/474120877/stanford-physicist-embarks-on-mission-to-improve-undergraduate-teaching

[23] http://www.gallup.com/opinion/gallup/182867/america-no-confidence-vote-college-grads-work-readiness.aspx

faculties" needing to be exercised. We still require every student to take a barrage of subjects that provide little educational value, but without which, individuals will be denied access to economic opportunity since no credential will be allowed if not acquired through the academic conduit. Either do as the establishment demands, regardless of quality, or else suffer marginalization! This is not the sign of a free country.

> [William] James had in 1890 fired one of the first salvos at the mental-disciplinarian notion of transfer when he reported that his experiments on memory had failed to show any improvement in what mental disciplinarians had imagined to be a discrete faculty of memory. If memory could not be improved by memorizing, then it could hardly be justified as a pervasive school activity, since much of what was being memorized was hardly worth committing to memory in the first place and would most likely be forgotten in any event. (Kliebard, p. 91)

What seems to have been overlooked is that educators were not measuring intelligence per se, but rather certain types of abilities such as the ability to memorize. To measure intelligence, one would need to see how an individual is able to solve real world problems – as opposed to academics' artificially designed problems suited and optimized to their own abilities – under many different scenarios that reflect all the human abilities man possesses. What would then be discovered is the types of talents/intelligences an individual possesses, which may not be related to academically oriented abilities as they are fancied today, but this does not mean an individual is any less intelligent than one who possesses them. It's simply a different type of intelligence or ability – nothing more, nothing less. This is something academics will find very difficult to swallow since they exert so much effort in their academic pursuits to "rise above others" and establish themselves in the "superior class."

The Organization for Economic Cooperation & Development (2013) offers:

> Skills are developed by use, and, in a pattern of mutual reinforcement, the existence of skills facilitates their use. … While these findings do not establish the direction of causality, independent research evidence supports the common sense view that skills are maintained and developed through practice (sometimes called the "use it or lose it" hypothesis). (p. 28)

In other words, regardless of level of education attained, the use and practice of numeracy and literacy skills, in the applied domain, reinforce their development and improvement, which, of course, is common sense. This part of the report also shows that applied studies in an educational setting is far more effective than the current disconnected and abstract curricula our system is based upon.

Regarding repetitive practice, in his chapter entitled *Is Drilling Worth It?*, Willingham (2009, p. 107) states, "It is virtually impossible to become proficient at a mental task without extended practice." This demonstrates that superfluous information can waste time and harm students' motivation since proficiency is such a time consuming endeavor. Pursuing proficiency in tasks that have marginal value (unless and until a career demands

it of an individual) can be seen as counterproductive. Such practice to achieve proficiency can only be extended to a limited number of mental tasks during an individual's years in school.

Willingham points out, "The bottleneck in our cognitive system is the extent to which we can juggle several ideas in our mind simultaneously." The goal is to make "costly" conscious thinking into habitual and effortless subconscious thought patterns so the mind may consciously focus on higher order challenges and issues and not be overwhelmed by too much information or too much sensory input (think of a nervous novice driving a car versus a relaxed accomplished driver). Therefore, the value of each task that may need to be mastered, requires it to be weighed against the value of other tasks to determine what the priorities should be, or what their "relative worth" is, as Spencer (1860) would phrase it.

The Myth of "Average"

Public education teaches to the "average student" due to its efficiency. This began around the turn of the last century by an arm of the Progressives called the Social Efficiency Movement. However, Hough (2015) quoting Todd Rose, professor of Educational Neuroscience at Harvard, provides, "The average is a statistical myth . . . There is no average. No average professor. No average worker. No average soldier. No average Joe." Instead Rose refers to a "jagged learning profile."

Rose says, "From the moment we're born to the moment we die, we are measured against a mythical yardstick – the average human – and it's hurting everyone." Rose wants to dismantle this *myth* and "instead help the public understand the importance of the individual." According to Rose, "We talk so much about the individual . . . but there's such a divide between what we say we believe and what we actually do."

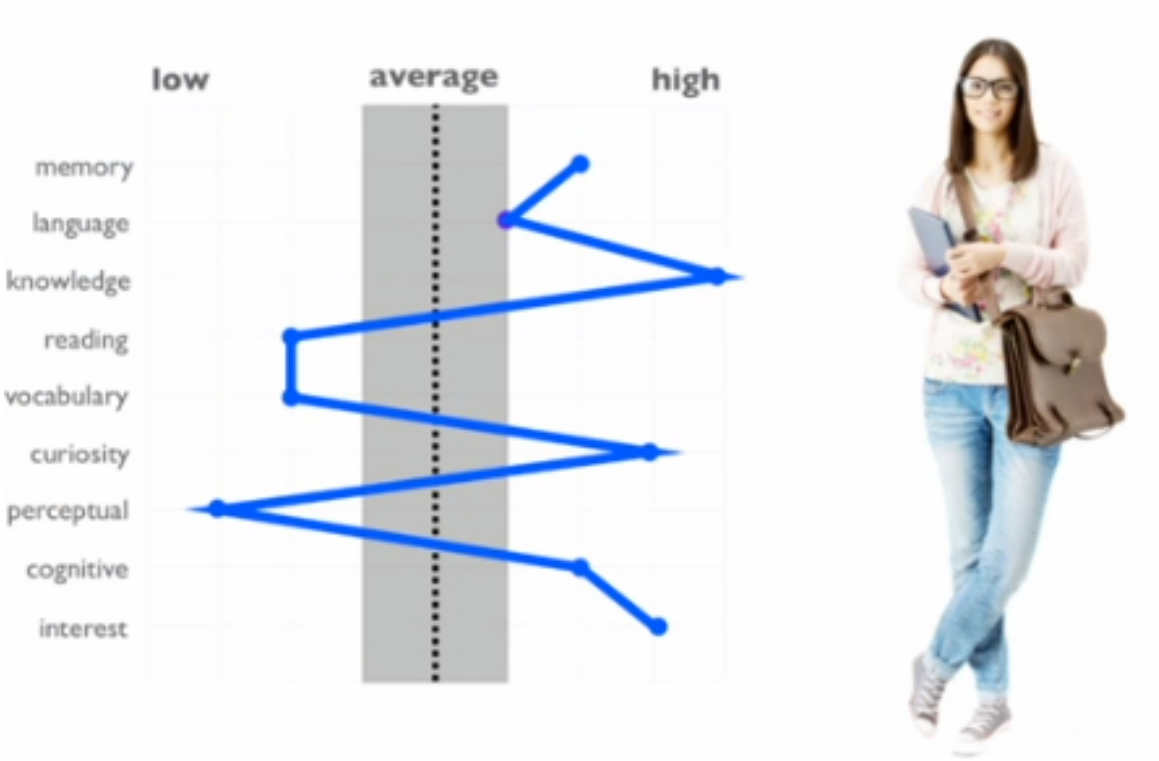
Rose references a situation in the Air Force in 1952 to make his point. They had great planes and good pilots, but were getting worse results. The Air Force started blaming the pilots, the technology, flight instructors, but none of these were the cause. It was the cockpit that was causing such terrible flight results, because flying requires such quick reflexes. It's imperative that cockpits be properly fitted so pilots can quickly reach the necessary instruments. The problem rooted in the cockpits was that they were designed for the statistically average man.

An Air Force researcher, Gilbert Daniels, found proof that applying concepts of statistical averages was an impractical farce. (Rose claims that statistical averages came from, "the industrial age by people who were 'absolutely obsessed' with averages because averages worked so well in factories.") Gilbert Daniels studied over 4,000 pilots and measured them by 10 dimensions of size, since fitting into a cockpit properly is more complicated than just someone's height. It was assumed that most of them would fit the statistical average by all ten dimensions, although all 4,000 pilot's measurements resulted in zero pilots who were average in all ten dimensions. This proved to the Air Force that there was no such thing as an *average* pilot. Gilbert Daniels called it the "jagged size profile"

and if every person has a jagged size profile than anything designed for the “average person” is designed for no one. It raises the question: Is this an unsettling thought or a comforting one? For an institution, it is unsettling, but for individuals, it is comforting, because it is reassuring to know that the institutions we have been taught to trust, but we never felt all that comfortable in, were the problem – not us individually.

The Air Force made a bold decision to outright ban the average and had manufacturers design cockpits to the edges of the jagged profile. Manufacturers were outraged and didn't believe such a thing was possible, but the Air Force wouldn't buy jets until this was accomplished. The manufacturers successfully designed a cockpit for the edges of the jagged profile and came up with adjustable seats designed for any extreme. This design was eventually incorporated into cars, which we use to this day.

When trying to apply averages to students there is a total lack of nurturing of individual creativity and development. As Rose states, “Human beings don't line up perfectly. There is no average learner. They have strengths and weaknesses. They all do. Even geniuses do.”



Jagged Learning Profile

Statistics don't inform us about individuals. Rose says that, “understanding individuals means really explaining individuality and variability rather than ignoring it or explaining it away.” Just like the Air Force, we can’t just blame the teachers and students. Most K-12 textbooks are based on chronological age to be educationally appropriate. The concept is rooted on a hypothetical student that doesn't actually exist. Rose says, “Walk into any

elementary school classroom and even the literal design of the room is for the 'average' kid: one size desk, one size chair, one size table. But just as there isn't one size pilot, there isn't one size student or one way to learn. … Every student has a jagged learning profile."

Quick (1894), in his criticism of Locke, reveals his biases that have become part and parcel of the educational community as it relates to looking for commonality in students so that the "average" might be taught to.

> [Locke] makes little attempt to reach a scientific standpoint and to establish general truths about our common human nature. He thinks not so much of the man as the gentleman, not so much of the common laws of the mind as of the peculiarities of the individual child. He even hints that differences of disposition in children render treatises on education defective if not useless. "There are a thousand other things that may need consideration" he writes "especially if one should take in the various tempers, different inclinations, and particular defaults that are to be found in children and prescribe proper remedies. (p. 229)
>
> No language could bring out more clearly the inferiority of Locke's standpoint to that of later thinkers. He makes little account of our common nature and wishes education to be based upon an estimate of the peculiarities of the individual pupil and of his social needs. (p. 230)

While commonality has its place – after all, we are all human and must be educated as such rather than some other animal might be trained – individual differences are actually more important. While teachers are certainly aware of this, the system, with its assessment tests dictating everything, does not provide them the means to address this most important issue, and eventually, many become numb to individual problems (call it a survival strategy so teachers' hearts are no longer broken by students who do not fit in). After all, the teacher must shoot for the target if she wishes to keep her job. If the target is testing, then she has no choice but to teach to the test, and testing is designed for the "average student." Hence bell curves inform educators whether they teach to the average. If the curve shifts one way or another, educators shift their strategy to ensure they teach and test to the middle. In other words, there must be a significant percentage of "losers" in the exclusive academically optimized system, otherwise they are not doing their job. There is no room for the individual in this highly bureaucratic statist world. Parents would be well advised to either force change upon the system – such as the voucher system offers, for example – or withdraw their children from it and find alternatives.

To summarize, *How People Learn II* (2018) offers an explanation of the balance between our commonality as a social being and our individual uniqueness: "While humans share basic brain structures and processes, as well as fundamental experiences such as relationships with family, age-related stages, and many more, each of these phenomena are shaped by an individual's precise experiences." Like Henry de Bracton's (c. 1210 – c. 1268) legal principle where there are absolute truths in conjunction with subjective or

relative truths, the human brain is a human brain at its base – this is a truth – however, brains and experiences are not identical which is where subjective or relative truths arise.

Fluid & Crystallized Cognitive Abilities

The National Academies of Sciences (2024) report on military education and training discuss fluid and crystallized abilities. They analyze adult versus youth pedagogy.

> An array of theories about abilities exists, but most relevant to adult learning is one that considers both crystallized and fluid abilities. Crystallized abilities comprise areas of knowledge acquired through experience, including that related to formal education. … Because the development of crystallized abilities depends heavily on experience, vocabulary and verbal skills tend to grow with sustained literacy practices, and crystallized knowledge in specific domains (e.g., history, science), are more likely to flourish in areas consistent with the individual's interests and personality, presumably because people are more likely to habitually engage over time with activities they enjoy or find fulfilling. For example, people with stronger investigative interests (who enjoy thinking through problems) tend to know more about the sciences and technology, while those who find enjoyment in artistic activities know more about art.
>
> Theoretically, developing crystallized abilities depends on an individual's investment of effort and attention over time. As such, developing domain knowledge is highly individualized, idiosyncratic, and dependent on a person's interests, education, and experiences. For example, an individual is likely to show growth in knowledge as a consequence of activities related to their occupation or hobbies. Thus, interest is a prime motivational driver for the development of domain-specific knowledge. Unsurprisingly, individual differences in knowledge structures increase with age, given the idiosyncratic nature of experiences, education, hobbies, and occupations people are likely to have. Thus, assessments of such specialized knowledge call for more personalized evaluation methods.
>
> Fluid ability, sometimes referred to as mechanics, encompasses the mental operations— including memory, attentional control, novel pattern recognition, and spatial processing—needed to adapt to novel circumstances, especially in situations that require rapid responses.[24] … As with the development of crystallized ability, there are large individual differences in trajectories of fluid ability, with variability depending largely on health and fitness, providing a potential benefit to military members, who tend to prioritize fitness.[25]
>
> Fluid ability, as with crystallized ability and knowledge, is not a single, cohesive entity. Rather, it is a constellation of cognitive skills engaged for performing

[24] We can refer to this as medium to far transfer.

[25] This points to the value of health and fitness which provides the evidence for including such issues in education based on Spencer's relative worth measurements. Box 4-2, pages 113-14, of the report discusses research that makes the correlation between healthy cognition and exercise.

across activities. Working memory—the capacity for holding information in mind while engaging the numerous mental operations used to control attention and work with that information—is a concept closely related to fluid ability. While not identical, measures of working memory, such as holding a set of numbers in mind while understanding a sentence, typically correlate highly with measures of fluid ability and are often predictive of learning and memory.

… Another construct that is closely related to fluid ability and working memory is that of executive control (also called attentional control and executive attention), generally conceptualized as the ability to maintain focus on task-relevant information and to inhibit irrelevant information. While measures of fluid ability, working memory, and executive control often show some intercorrelation, conceptualizations vary with respect to the cognitive architecture relating these three capacities. Executive control shows notable growth through childhood and adolescence, and like fluid ability and working memory, declines through the adult lifespan.

… How education is structured also matters. Even though the fruition of adult cognitive development is often taken to be high levels of specialized expertise in some domains, such as medicine or engineering, the most effective educational pathway to achieving that goal may not be an early focus within one's domain of specialist training. Instead, more generalist training that increasingly transitions into domain-specific specialization may optimize developing expertise. For example, world-class athletes in a specific sport typically have early training in an array of different sports relative to national-class competitors. Also, relative to national award winners, Nobel laureates typically have more early experiences in academics and work that are in areas other than the discipline in which they received their awards. Generalist training may also contribute to developing critical reasoning skills. For example, college students who take more courses outside their major show larger gains over two years in a composite measure of logical reasoning on well- and ill-defined problems.

Even though education is a powerful force in shaping adult development, ongoing engagement in mentally stimulating activities, such as complex work, social interactions, and hobbies, may continue to shape cognition through the adult lifespan. Cross-sectional correlations between such forms of engagement and cognition are often found, which provides very weak evidence for a causal account. Somewhat stronger evidence is found in longitudinal data showing early-life enrichment to predict the level of—or change in—later cognition performance.

… Most adults invest at least some time—more typically, a great deal of time, in work activities that support their careers, so it is not surprising that cognitive development can be shaped by work. For example, longitudinal data from a sample of adults ages 16 to 65 at baseline showed a reciprocal relationship over 30 years between mental flexibility and substantively complex work that places

> demands on the individual for autonomy and self-directed problem solving in ill-defined situations.
>
> … Novelty— the degree to which a job requires learning new things, offers opportunities for exposure to new information, and depends less on routines—is another feature of work that may support intellectual growth. One study found that novelty in work predicts reduced cognitive declines over 14 years in later midlife (Staudinger et al., 2020). On the other hand, job complexity, novelty, and autonomy have been found to predict levels of fluid abilities, crystallized abilities, and processing speed in midlife, but not changes in cognition over the subsequent 20 years. (pp. 111-17)

In the report's section, "Stability and Change in Learning New Things through the Adult Lifespan," we develop some insight in what youth must prepare for as they age. It also informs educators what they must provide youth in order to make learning comprehensive with the fewest barriers that is humanly possible.

An important consideration: Building blocks of the chronology of learning need to be experiential as much as possible since it crystalizes it more than textual reading. However, textual reading of theory, for example, anchors it deeper.

> Given the discussions above, what are the implications of these changes in cognition and motivation for learning new things? Fluid and crystallized abilities, as well as domain-specific knowledge, contribute to the ability to learn new things.
>
> … Theories of skill acquisition highlight the stages of learning and their ability correlates. At early stages of the learning process, for example, the competencies to be learned are novel, so learning requires focused attention and effortful processing. As such, at early stages of learning novel tasks, fluid abilities can be the most important determinants of learning. As one acquires knowledge or skills, the learner enters the knowledge compilation phase in which learning is relatively less effortful. At this stage, fluid abilities are still important, but more domain-specific abilities that are similar or related to the skill being learned become important determinants of learning.
>
> … Similarly, assembling a particular piece of equipment for the first time is likely to depend more on fluid abilities to understand the relationships among components and the mapping between instructions and actual assembly procedures, especially if the individual has little experience with assembly activities in general. As the individual gains more experience assembling the piece of equipment or similar pieces of equipment and develops skills to identify and distinguish among components and conceptual spatial relationships among the components that fit together, for example, the more an accurate and efficient assembly will depend on knowledge and the less it will depend on fluid abilities.

> In general, people are more efficient in learning new information related to existing knowledge, but the accumulation of competencies through adulthood exaggerates this effect. While individuals with high levels of crystallized verbal ability typically show a general advantage in comprehending and learning from text, content knowledge related to the text confers distinct advantages in selecting the meanings of words in context, making inferences, and comprehending the mental model of situations or events described by the text. Knowledge also tends to correlate with interest, which at least partially explains why middle-aged and older adults prefer routes to learning that depend on existing knowledge; that is, as people develop expertise it becomes increasingly effortful to pursue learning in completely new directions.[26] Collectively, mature adults have an advantage in learning in domains in which they already have some knowledge and experience, both because cognitive processing is more efficient and because people are motivated to orient attention to things they find interesting. Thus, cognitive and motivational processes interact to support learning among mature adults.
>
> Despite replicable declines in fluid ability and working memory, there is no evidence that aging compromises work performance. There are likely many reasons for this, including the important role that knowledge plays in effective work performance, motivational processes that engender selective optimization to support deeper levels of expertise, and the way knowledge-based compensation can offset any effects of age-related declines in speed or fluid abilities. (pp. 136-38)

Multiple Intelligences

Bennett (1937) considers the differences in abilities/intelligences, in particular as it relates to the manual arts, with the following:

> But, further, men are from birth very different both as regards mental faculties and bodily qualities. These faculties, which often run in different directions, cause those things to appear comparatively easy to one person, which to another appear very difficult, if not, indeed, almost insurmountable. As one child may have a turn for arithmetic, whilst the case is quite the reverse with another; so the achievement of the same exercise may, on account of different faculties or predispositions, afford greater difficulties to one person than to another.

To better understand transfer of learning, Gardner's multiple intelligence theory (1983) proves to be a useful tool. Gardner points out that our traditional understanding of intelligence is not only severely flawed, but it is simply wrong as it relates to a "single general capacity," identified as "*g*," measured by IQ or other assessment type tests, that purport to determine where an individual falls on the ranking "intelligence scale." Since we teach for tests based upon a false god, i.e. IQ or other such flawed measurements, we don't teach for transfer.

[26] Perhaps this explains "closed mindedness."

> As I have noted, the tests have predictive power for success in schooling,[27] but relatively little predictive power outside the school context…. There is no view of process, of how one goes about solving a problem: there is simply the issue of whether one arrives at a correct answer. … [I]ntelligence tests rarely assess skill in assimilating new information or in solving new problems. This bias toward "crystallized" rather than "fluid" knowledge can have astounding consequences. An individual can lose his entire frontal lobes, in the process becoming a radically different person, unable to display any initiative or to solve new problems – and yet may continue to exhibit an I.Q. close to genius level. (Gardner, pp. 16-18)
>
> My own analysis suggest that apparent support for "*g*" comes chiefly from the fact that most tests of intelligence are paper-and-pencil exercises which rely heavily on linguistic and logical-mathematical abilities. Hence, individuals strong in these two areas will perform well on tests of general intelligence, in contrast to individuals whose strengths lie elsewhere. Schools cherish these capacities for "mental manipulation," which is why "*g*" can predict success in school with some accuracy. (Gardner, pp. 320-21)

This is extremely important for citizens to understand because this fundamentally flawed reasoning of what assessment tests really signify, steers educational resources and efforts in the wrong direction, thereby doing tremendous harm to a majority of citizens, thus harming society. General intelligence is a measure of "paper and pencil" test-taking abilities – which depend on memory and recall – rather than a measure of intelligence; and IQ measurement is a reflection of this extremely flawed and harmful theory of intelligence. Therefore "*g*" is a misnomer; that is, it is not *general* but is really fairly specific. After all, it doesn't touch on something as important as perceptual motor skills abilities, which has great importance to individuals and society. "*g*" also does not touch on rational or intuitive thinking, which are superior to IQ when living in the real world; the concept of which horrifies academics since it would expose the subpar abilities in many of them.

Something that never seems to be included in the formula for determining an individual's "intelligence" is the part teachers and curricula play in a student's grasping of what is taught. Granted, test taking is a talent unto itself, but what if the teacher was different or curriculum was written differently? Would we see different results? The answer is an unequivocal YES! However, academics are typically institutional type people and such people tend to avoid blaming institutions since they are the breast at which academics feed. People tend not to bite the hand that feeds them.

Willingham (2009, chapter 7) surveys Gardner's theory, questioning certain aspects while criticizing later interpretations by others. Willingham has analyzed a great deal of

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[27] This is true because tests and curricula have been optimized for one another. They are intricately tied, and since tests cannot measure transfer, curricula must avoid it – it cannot be otherwise as long as our assessment instruments remain unchanged. Therefore, tests have been optimized for memory and recall abilities based on disconnected data that schools find less challenging to teach.

research done by various cognitive psychologists on teaching methods designed based on multiple intelligences and points out that none have been able to find evidence of methods that improve educational outcomes. However, it is highly likely that most cognitive psychologists have framed their research within the "college prep" and "college for all" realms, which is an optimized system for certain talents, such as test taking. Such a bias marginalizes those who do not possess the talents for the optimized system.

In my essay *Quality of Education* (2017) pages 22 and 23, I reference an OECD report[28] demonstrating that high school students who pursue a technical program, improve their literacy and numeracy skills significantly. Perhaps if cognitive researchers were to incorporate CTE in their work, they might find revealing results for the multiple intelligence theory.

There is an academic faith akin to religious beliefs that asserts intelligence is defined by how well one performs in a public school and then on assessment tests. Of course, this serves those of this factional belief system since it draws power and wealth for their self-serving interests. However, few people understand that what goes by the name of education in the public system, is an optimized[29] curricular program for those with linguistic and logical-mathematical talents coupled with memory retention and recall capabilities. However, Jardine (1827) pointed out long ago that "A young man may be a good linguist or mathematician, and yet be utterly unqualified for the numerous duties which belong to the citizen of a free country." (pp. 13-14)

Gardner states:

> It is evident that, with few exceptions, societies are not interested in "pure" intellectual competences: there are few occupational roles that the *idiot savant* of linguistic, logical, or bodily intelligence can perform. Rather, in nearly all socially useful roles, one sees at work an amalgam of intellectual and symbolic competences, working toward the smooth accomplishment of valued goals. (pp. 316-17)

Gardner makes a very important argument against the necessity of memory and recall abilities. He points out that "during Classical and medieval times, elaborate systems for aiding memory were devised, including number lists, intricate images, spatial codes, zodiac systems, and astrological schemes." (p. 92) This would have been important for the majority of people who could not read or did not have access to the expensive hand-written books of the times. However, times changed, as Gardner points out:

> While the person who could remember well was once at a tremendous premium, the advent of literacy, and the possibility of writing down information in books available for ready consultation, made the possession of a powerful verbal

[28] OECD Skills Studies, *Time for the U.S. to Reskill? What the Survey of Adult Skills Says*, Organization for Economic Cooperation & Development, 2013.

[29] Mestre et al. reveal "Optimizing instruction for … classroom achievement may have deleterious consequences for … transfer of broader principles to novel problems in different contexts." (p. 296)

> memory less vital. Later, printing rendered this aspect of linguistic intelligence even less valuable. And yet these abilities continue to be cultivated in some circles. (p. 92)

As he informs us, the need for a powerful memory has diminished substantially now that most people are literate and print media is inexpensive. What then becomes more important is the ability to research information and then to draw reasoned conclusions from the research where decisions can be made and acted upon.

Gardner theorizes there are several different intelligences that the public system doesn't even recognize but are every bit as important as the two the system is designed for, which is logical-mathematical and linguistic. He lists seven intelligences, though he admits this is not the final say on the subject. They are: linguistic, musical, logical-mathematical, spatial, naturalist, bodily-kinesthetic, interpersonal, and intrapersonal intelligences.

In considering how much of each of these intelligences individuals possess, Gardner says:

> Owing to heredity, early training, or, in all probability, a constant interaction between these factors, some individuals will develop certain intelligences far more than others; but every normal individual should develop each intelligence to some extent, given but a modest opportunity to do so. (p. 278) … Yet it should be evident, even to casual observation, that commitment in one or another intellectual sphere may entail high degrees of motivation or attention, without similar investments being evident in other areas. (p. 286)

In elaborating on musical intelligence, Gardner cites the Suzuki method of teaching children how to play a musical instrument. Gardner states:

> In Japan, the great master Suzuki has shown that large numbers of individuals can learn to play musical instruments extremely well … even at an early age. To be sure, most of these individuals do not go on to become concert musicians – a result that does not disturb Suzuki, **who sees his goal as the training of character**, not of virtuoso performance. (p. 112) (Emphasis added.)

We need to think in these terms as it relates to much of what is taught in education, i.e., the knowledge imparted is secondary to developing character in people.

Gardner states:

> With such considerations in mind, I have formulated a definition of what I call an "intelligence." An intelligence is the ability to solve problems, or to create products, that are valued within one or more cultural settings – a definition that says nothing about either the sources of these abilities or the proper means of "testing" them. (p. x)

Gardner points out that some people prefer not to use the word intelligence when describing multiple mental abilities and faculties. *Ability* or *talent* is preferred by some, and I happen to fall within this camp. I would argue that the word "intelligence" has been so narrowly defined by IQ and abused by academia that it has lost real significance and therefore needs to be abandoned at this point just like the words *imbecile*, *moron*, and *retarded* have been abandoned due to the abuse of them, which led them to become offensive words. The words *talent* or *ability* better fit the interpretation of the eight "intelligences." Therefore, logical-mathematical and linguistic "intelligences" should be referred to henceforth as talents or abilities.

Regarding the scientific community's belief system, Gardner makes an interesting observation our society needs to consider when listening to what scientists of various disciplines claim upon coming to some conclusion they believe in.

> [I]n the final analysis, science itself is virtually a religion, a set of beliefs that scientists embrace with a zealot's conviction. Scientists not only believe in their methods and themes from the depth of their being, but many are also convinced it is their mission to use these tools to explain as much of reality as falls within their power. (p. 150)

It is well and good that society hears what scientists offer, but people need to be cautious in buying what is being sold. Theories are frequently proven wrong and are evolving constantly. Therefore, individuals should keep an open mind of what scientists offer, but until a theory has proven itself sound, it is best not to embrace scientific findings with religious zeal – as most people embrace IQ rankings. Of course this includes psychology as it relates to education and learning. After all, British educational psychologist Charles Spearman (1863-1945) "believe[d] in the existence of '*g*' – a general overriding factor of intelligence which is measured by every task in an intelligence test." (Gardner, p. 16) Spearman was not only off the mark, but his concepts have harmed tens if not hundreds of millions of Americans since his day by labeling and categorizing people in an "intelligence" ranking. Such rankings have opened doors to some and closed them to many without any evidence of the efficacy of the ranking outcomes as it relates to real world applications. In addition, the "intelligence" testing movement of the early 20th century led to eugenics in the U.S.,[30] which the Nazis took to the next level of genocide.

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[30] The U.S. Supreme Court eugenics case, *Buck v. Bell*, 274 U.S. 200 (1927), is a prime example of where intelligence testing led this country. Carrie Buck, "a helpless woman of normal intelligence and poor background" (Epstein, 2006, p. 107) who had been raped by a foster family member, was sent to a State epileptic and feeble-minded institution. One Dr. Priddy, an enthusiastic social engineer, wanted to sterilize Ms. Buck. The case was taken to the Supreme Court by Priddy and others hoping to set a precedent so they could continue their mass sterilization work of those they deemed "shiftless, ignorant, [and a] worthless class of antisocial" citizens. Justice Oliver Wendell Holmes, Jr. concurred. He believed it was constitutional to sterilize those the State deemed eugenically inferior, which was part of the Progressive movement of the period. He continued, "The principle that sustains compulsory vaccination is broad enough to cover cutting the fallopian tubes. Three generations of imbeciles are enough." Something that must not be forgotten: The Nazis commended the eugenics work done in the U.S. during the 1920s and 30s (when 60,000 U.S. citizens were sterilized), which provided justification in the minds of Nazis to pursue genocide of the Jews. (Murrin & Webster, 2013, p. 156)

This reveals the dangers of buying into "scientific" findings where insufficient proofs have been forthcoming. Faulty science has its consequences when society buys into it.

Some thoughts from Gardner are useful in seeing some of what's missing from public education:

> It should be pointed out, once again, that even if one's cognitive mechanisms are in order, educational progress will not necessarily result. Most contemporary psychological analyses assume an individual eager to learn; but, in fact, such factors as proper motivation, an affective state conducive to learning, a set of values that favors a particular kind of learning, and a supporting cultural context are indispensable (though often elusive) factors in the educational process. Indeed, one of the Venezuelan-supported research projects has concluded that **proper motivation to learn may well be the single biggest difference between a successful and an unsuccessful educational program (and learner).**[31] (p. 373) (Emphasis added)

> [I]t is a principal assumption of this study that individuals are not all alike in their cognitive potentials and their intellectual styles and that education can be more properly carried out if it is tailored to the abilities and the needs of the particular individuals involved. Indeed, the cost of attempting to treat all individuals the same, or of trying to convey knowledge to individuals in ways uncongenial to their preferred modes of learning, may be great: if at all possible, it is advisable to devise methods for assessing the intellectual profiles of individuals. (p. 385)

In his attempt to demonstrate the need for change in the then current educational system, Comenius (1633) precedes Gardner's multiple intelligences with the following:

> [E]ach individual creature not only suffers itself to be easily led in the direction which its nature finds congenial, but is actually impelled towards the desired goal, and suffers pain if any obstacle be interposed.
>
> A bird learns to fly, a fish to swim, and a beast to run without any compulsion. They do these things of their own accord as soon as they feel that their limbs are sufficiently strong. (p. 84)

The Animal School: A Fable helps get this point across (see http://agsc.tamu.edu/384/AnimalSchool.pdf).

Comenius asks the question for students who do not perform well in school, "But how does the matter stand if it be shown that the teacher is the reason of a pupil's aversion to learning." It cannot be doubted that a certain percentage of students' problems originates from improper instruction. Do we simply write these students off as a statistical

[31] For further analysis on motivation, *see* *Adult Learning in the Military Context*, National Academies of Science, 2024, pp. 119-35.

percentage that we have to accept in a monopolistic public system that uses compulsion to guard its own interests? Is this not doing violence to these individuals? Is this not what a free government is meant to guard against? Or have we completely abandoned free government and surrendered to statism?

Comenius addresses character differences in students – something our educational establishment knows exist but provides little to teachers in working with or around these various attributes. He identifies the differences as: sharp versus dull, soft and yielding versus hard and unbending, eager for abstract knowledge versus eagerness for applied knowledge, and then states "From these three pairs of contradictory characters we get in all six distinct divisions." (p. 88) Comenius then attempts to qualify these character differences in relation to methods in guiding students on the learning path. He makes distinctions between those who are naturally inclined to learn academic information and those who are not; and he makes a point of not burdening students too heavily with demands that will dishearten the various character types. He states, "Though [some] pupils take longer to come to maturity, they will probably last all the better, like fruit that ripens late." (p. 89)

Our current system makes this next to impossible for teachers since they are heavily burdened with so much superfluous information to teach, there is no time to guide students. It's a sink or swim environment where survival of the fittest rules! And it must be made clear, this is not the doing of individual teachers. They are handed an impossible task, literally, and they must make the best of it. Therefore, when I criticize "educators," "academics," the "educational establishment" or "educational culture," etc. in general terms, I am not speaking of the K-12 teachers in the trenches for the most part, but of those in positions who influence the path education takes. Granted, there are those in positions of influence who understand the changes that need to be made, but they're in the minority.

What must be considered is the balance between the necessary knowledge individuals need as citizens in a free country and the fire or spirit of each individual. Education, being such an extensive part of our current lives, can extinguish the fire if not handled correctly. It is better to have no education than to have one's fire extinguished.

To conclude this section, a concept entered my mind that may or may not have merit. I have read, somewhere in the past, of an evolutionary concept that may apply to the limits of human talents/abilities/intelligences. The concept has to do with animals' abilities and lack thereof. The owl has perhaps the best hearing of any animal. It can catch its quarry in complete darkness, with the aid of hearing alone. Diurnal raptors' eyes are said to be so keen that if they were capable of reading, they would be able to decipher the headlines of a newspaper a quarter mile away. The hound's nose is so sharp, it can track an animal hours after it passed through an area.

Each of these predators have a sense perception that stands out as being superior above most other animals; yet none possess the combination of them all to the superior level. Why is this? It has been speculated that such a predator would be so superior that no

other animal would be able to escape and therefore extinction of multiple species would be the result. Therefore, evolution has designed predator and prey to have a balance that allows for the preservation of both.

Perhaps the limits upon multiple intelligences of individuals are a reflection of this dynamic. If one person, or a number of them, had the combination of all talents/abilities/intelligences of humans, those people would be capable of hoarding most, if not all, wealth and power. In effect, there would be few who could survive against such abilities. Of course, this could lead to the next stage of human evolution, but this does not appear to be the destiny of humans since no one in history has demonstrated such a potential. Therefore, we must be content with our limited individual capacities and see our talent as simply contributing to the community as a whole.

Personality Types

Carl Jung's Psychological Types, the subsequent Myers-Briggs Type Indicator, and the Big Five Personality Traits (not to mention the ancient astrological zodiac signs that are believed to be predictive of personality characteristics), though perhaps not living up to scientific scrutiny in its purest form, do provide observation of human characteristics that are real and require further investigation to better understand such traits as they relate to cognition, learning, and occupational pathways.

Though a 2008 Association for Psychological Science (APS) report concluded there is insufficient evidence that supports *learning style* theories (at least not in the way research had previously been conducted), few would question there are different personality types. If there are indeed different types, then it is reasonable to assume there are different strategies that would provide different outcomes. Perhaps the problem lies with the academic community's narrow focus on academic outcomes in contrast to outcomes that have to do with the real world, which is what humans are designed for. In other words, academia designs education programs and assessment testing for academic cultures which humans are not designed for. Humans are designed for real-world existence that academia is quite distant from – hence the term *ivory tower*. The countless occupational training programs offered by the various industries should provide the evidence that was missed by *learning-styles* proponents and therefore not captured by the 2008 APS report.

Stages of Development

Comenius addressed stages of development in Chapter VII in his *The Great Didactic* (1633), "A Man Can Most Easily Be Formed In Early Youth, and Cannot Be Formed Properly Except At This Age,"

> It is the nature of everything that comes into being, that while tender it is easily bent and formed, but that, when it has grown hard, it is not easy to alter. Wax, when soft, can be easily fashioned and shaped; when hard it cracks readily. A young plant can be planted, transplanted, pruned, and bent this way or that. When it has become a tree these processes are impossible. …

> It is evident that this holds good with man himself. His brain … because it receives the images of external objects that present themselves to its organs of sense, is, in the years of childhood, quite wet and soft, and fit for receiving all images that come to it. Later on, as we find by experience, it grows hard and dry by degrees, so that things are less readily impressed or engraved upon it. Hence Cicero's remark, "Boys pick up countless things with rapidity." In the same way it is only in the years of boyhood, when the muscles are still capable of being trained, that the hands and the other members can be trained to produce skilled work. If a man is to become a good writer, painter, tailor, smith, cabinet-maker, or musician, he must apply himself to the art from his early youth, when the imagination is active and the fingers flexible…. (pp. 58-59)
>
> [F]irst impressions cling so fast that nothing but a miracle can remove them. It is therefore most prudent that men be shaped to the standard of wisdom in early youth.
>
> Finally, it is most dangerous if a man be not imbued with the cleanly precepts of life from his very cradle. … [L]ater on, if it wish to unlearn what it has acquired, it finds this impossible or very difficult…. Hence the world is full of enormities which … the civil magistrates … are [un]able to quell, since no serious attention is given to the source from which the evil flows. (p. 60)

In Quick's analysis of John Locke, he states:

> The thought which underlies Locke's system of education is this: true knowledge can be acquired only by the exercise of the reason: in childhood the reasoning power is not strong enough for the pursuit of knowledge: knowledge, therefore, is out of the question at that age, and the only thing to be thought of is the formation of habits.

Of course, Aristotle spoke extensively on the development of good habits during childhood so that they become part of oneself when adulthood is reached.

Krug (1964) addresses the *child study movement*, also part of the Progressive Era reforms:

> [T]he child study movement had a definite impact on the discussions of secondary education, particularly as it enlarged its scope of activities from the study of very young children to include that of adolescents.
> … One of the first to proclaim the discovery of adolescence was Professor James Earl Russell of the University of Colorado…. In a letter written to the *School Review* in 1895, Russell identified the ages twelve and thirteen as the critical time when intellectual and physiological changes took place in the child. "He becomes, in short, speculative, philosophical. The child lives in a world essentially realistic; the world of the youth is essentially idealistic." Secondary education, he argued,

> should begin at that time. This point was echoed by the NEA Committee on College-Entrance Requirements, which identified "the seventh grade, rather than the ninth" as "the natural turning point in the pupil's life." [32]
>
> It was at the 1897 meeting of the New England Association, however, that the idea of adolescence as the determiner of the secondary school curriculum was vigorously advanced. Most of this session was dedicated to adolescence. Principal Fred W. Atkinson of the Springfield, Massachusetts, High School made the opening address, in which he asserted that the vital questions of secondary instruction were not "how much algebra shall be exacted of the college preparatory pupil, or how many pages of this or that Latin author translated, or how many English books *read*, and how many *studied*, but do college requirements tend to impoverish secondary education and are they based on a proper knowledge of the limitations and capacities of secondary pupils; are the present demands of the secondary schools too great for the physical and mental forces of any considerable number of pupils, and, is secondary instruction adapted to the needs and interests of the individual?" (pp. 116-17)

Jean Piaget's (Swiss developmental psychologist, 1896-1980), *developmental stage theory* provides a very general guideline to understand the progression of development and learning in youth. The various stages are critical periods for developing human attributes that are so important to individuals' ability to function efficiently and effectively in society. Think of a child being raised during Piaget's sensorimotor and preoperational stages of development (see below) having no exposure to language and then after this period is complete, suddenly being thrust into a language-rich environment. I think few would argue that though the child might learn to speak, its command of language could never be developed to the fullest potential the child would have been capable of had it been raised under a language-rich environment from birth. Now think of a young adult, who is not college bound, graduating high school at age 18 and suddenly being thrust into a labor market environment for which there was no preparation. Unnerving is a descriptive adjective for such a scenario and millions of young adults experience this annually.

Consider the days of apprenticeships in the cottage industry (pre-Industrial Revolution era) and how individuals would begin their apprenticeship between the ages of 10 to 15. Later than this and master craftsmen perceived individuals would be too set in their ways to be fully trainable. This correlates well with Andrew Carnegie's position that the great 19th century captains of industry did not pursue further formal education past their early to mid-teens since it would have deprived them of the necessary time needed to be dedicated to business during their formative teenage years when they were most capable of absorbing the nuanced details of a culture or industry. (Carnegie, pp. 109-14)

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[32] Historically, this was the point at which apprenticeships typically began, with the age of 15 seen as the latest date to begin an apprenticeship. This was simply common sense that had developed over millennia. What statement does this make about contemporary times where the educational establishment does its very best to extend adolescence into the mid-20s?

Let's consider Piaget's hypothesis as a template to base a philosophical approach for education. Piaget held that biological maturation and environmental experiences were the sources of cognitive development. He suggested there are four stages of development:

1. Sensorimotor – from birth to the acquirement of language.
2. Preoperational – roughly covering ages 2 to 7. They are not yet capable of processing concrete logic or mentally manipulate knowledge.
3. Concrete operational – this is the preadolescent years, ages 7 to 11 roughly. The use of logic has begun, but abstract thought is not yet sufficiently developed.
4. Formal operational – this is the adolescent years, roughly ages 11 to 20. Individuals are capable of comprehending abstract concepts through logic. They can also understand how they learn (metacognition) and develop problem-solving abilities.

These stages should be seen as rough estimates, or averages, with widely varying application. After all, as Rose demonstrates, averages might be fine for a population under analysis, but there is no average person since no person has all of the attributes observed in an average population. In addition, Gardner establishes an understanding of multiple intelligences that will certainly effect how individuals pass through each of Piaget's stages. Therefore, we should use Piaget's concepts as general references, rather than a concrete recipe to follow. It will need to be adapted by educators as individuality reveals the uniqueness of each student.

Addressing Piaget's stages of development, Gardner (p. 314) has this to say on the subject:

> A … controversial area concerns the existence of stages of development, and the extent to which such stages may be linked to certain ages. As articulated by Piaget, the strongest position here holds that there are indeed discrete stages of development, which are qualitatively different from one another and stipulate characteristic world views. Moreover, as part of this point of view, there is the frequent rider that the stages of development are age-linked; and that if the child does not pass smoothly through a stage at the appropriate age, his subsequent development will be forever askew.

If we analyze the various stages Piaget postulates, it becomes clear that certain individuals may never have fully completed a given stage, such as the egocentric stage where an individual may have difficulty seeing the viewpoint or concern for others.

National Academies of Sciences (2018, p. 57), in reference to critical and sensitive periods in development of children, provides further insight into stages of development and their importance to the growth of each individual.

> Both critical and sensitive periods influence later development: an interruption (e.g., insufficient or inappropriate stimulation) during these times leads to difficulty (or even inability) to process in the affected domain later in life. The

> importance of these periods is further evidence for the vital importance of high-quality early childhood education, particularly for children who are at risk (Chaudry et al., 2017).

As the need for the fulfillment of Piaget's various stages relates to education, it becomes clear that those subject areas that are critical for individuals to develop for their own needs, demands significant investment in time, which renders superfluous instruction as wasteful and possibly harmful if not designed for stage related development. If foundational education is not achieved at the appropriate time in an individual's development, all subsequent stages of education typically go askew or are stunted. This is why it is so important to identify literacy and numeracy education as being the priorities and all other disciplines/subjects merely providing the means to this end during the primary school years and, to a certain extent, during the secondary school years. That is, these secondary support subjects must be designed for the development of literacy and numeracy attainment without consideration for memorization of superfluous facts or data that specialists in these secondary subject areas deem so important.

We have lost sight of what the formative years mean and how important they are to individuals to develop and refine talents that will be so very important in their life in all of its social manifestations. Currently, every child is forced through a narrow passage of training, we call public education, which is designed for the mythical "average student" that is based on a one-size-fits-all college prep philosophy. As Rose argues, being designed for the "average" means it is designed for no one. Therefore those who are not destined for college are severely inhibited from development during their secondary school years – i.e. the middle and high school years. Breadth and depth of learning for transfer will therefore be stunted under the current educational regime and individuals will never reach their full potential. Our political and economic world is too complicated a place for the majority of citizens to be left to their own devices, as is currently the case.

Since we know that the majority of students are not college bound, and in addition, most **should not** go to college, it is imperative that we recognize the importance of stages of development in youth and design an extremely flexible education program during the formative years that provide pathways suited to individual needs rather than for institutional and monetary conveniences. After all, how much money do we save when we ignore our youth during critical stages of their development, but then have to deal with them once grown up when many turn to social deviant behavior in a multitude of ways?

A side note to keep in mind when we consider the impact of deficient development in a stage: Barry (2009) had crossed eyes known as strabismus.

> Her brain had learned to suppress the image from one eye or the other so that she did not experience a confusing double vision. Normally the brain constructs a perception of depth by comparing the images from the two eyes, but in Sue's case, where one or the other image was suppressed, no such comparison was possible.

> So, though she had learned to judge distance and depth by other cues, she had never experienced true 'solid vision,' or stereoscopy. Her world was entirely flat. (p. xi)

It is understood that the first three or four years of life are critical periods in sensory development and if sufficient development does not occur in this time frame it would never be acquired, and "the critical brain cells and circuitry needed for stereovision would fail to develop." (p. xiii) However, after receiving vision therapy, Barry achieved stereovision at the age of 50. What happened?

> [Barry] has interviewed many eminent vision researchers and pondered the problem of critical periods with them. Her experience indicates that there seems to be sufficient plasticity in the adult brain for these binocular cells and circuits, if some have survived the critical period, to be reactivated later. In such a situation, though a person may have had little or no stereovision that she can remember, the potential for stereopsis is nonetheless present and may spring to life – most unexpectedly – if good alignment of the eyes can be obtained. That this seems to have happened with Sue after a dormant period of almost fifty years is very striking.
>
> … Sue's case, together with many others, suggests that if there are even small islands of function in the visual cortex, there may be a fair chance of reactivating and expanding them in later life, even after a lapse of decades….

If this is true for vision, it is probable this is true for other brain functions. This reveals that even though an individual may appear to be weak in a given area of human ability or a given discipline at a particular stage of development, it doesn't mean educators should abandon hope and thereafter marginalize individuals that "don't make the grade." If vision were to be judged by educators, Barry – a scientist – would have been labeled "stupid" by insensitive teachers who may very well have then given up on her.

Grandin (2022) is mildly autistic yet she acquired a Ph.D. and became a professor at Colorado State University. She has discussed her strengths and weaknesses extensively, including and excellent interview with Jordan Peterson where she contrasted her visual-spatial abilities to his verbal abilities, admitting she is weak in Jordan's realm.

On the dust cover, it points out that our brains are wired differently:

> With her genius for demystifying science, Grandin draws on cutting-edge research to take us inside visual thinking. Visual thinkers constitute a far greater proportion of the population than previously believed, she reveals, and a more varied on, from the photorealist "object visualizers" like Grandin herself, with their intuitive knack for design and problem solving, to the abstract, mathematically inclined "visual spatial" thinkers who excel in pattern recognition and systemic thinking. She also makes us understand how a world increasingly geared to the verbal tends to sideline visual thinkers, screening them out at school and passing over them in the workplace. Rather than continuing to waste their

> singular gifts, driving a collective loss in productivity and innovation, Grandin proposes new approaches to educating, parenting, employing, and collaborating with visual thinkers. In a highly competitive world, this important book helps us see, we need every mind on board.

Barry and Grandin show that the development of brain circuits related to the various human abilities are important to be aware of when designing curricula that embraces all learning types and styles; but how much development occurs for each ability is relative to the individual and to that individual's environment – in particular, the education paradigm in which learning takes place. This is an example of why the design of current curricula, as well as the testing and grading selection process in academia, is incredibly detrimental to individuals (including academic types themselves) and society. It will take a grass roots revolution for the education paradigm to transition to the needs of real people.

Curriculum Design Parameters

"*To know by rote, is no knowledge, and signifies no more but only to retain what one has entrusted to our memory*." Montaigne (1580). Therefore, to design curriculum for test taking is to ignore the purpose of learning, which is all about transfer.

"*A mere bookish learning is a poor, paltry learning; it may serve for ornament, but there is yet no foundation for any superstructure to be built upon it, according to the opinion of Plato*" Montaigne (1580). And then we wonder why most high school and college graduates are typically unprepared for the real world – they've only had "mere bookish learning."

Much of the content in this essay provides a critical analysis of contemporary public education from a broad perspective. Let's now turn to a cognitive psychologist who has identified a number of instruction techniques to foster retention, discernment, understanding, and transfer of learning, which is typically missing from the classroom.

Daniel Willingham (2009, pp. 3-9) provides a closer analysis of some of the ways instruction can be improved. In attempting to answer the question the title of his book poses, *Why Don't Students Like School?*, he offers:

> Contrary to popular belief, the brain is not designed for thinking. It's designed to save you from having to think, because the brain is actually not very good at thinking. Thinking is slow and unreliable. Nevertheless, people enjoy mental work if it is successful. People like to solve problems, but not to work on unsolvable problems.
>
> … People are naturally curious, but we are not naturally good thinkers; unless the cognitive conditions are right, we will avoid thinking.

> … You can appreciate the power of your visual system by comparing human abilities to those of computers. When it comes to math, science, and other traditional "thinking" tasks, machines beat people, no contest. Five dollars will get you a calculator that can perform simple calculations faster and more accurately than any human can.
>
> … [T]hinking is *effortful*; you don't have to try to see, but thinking takes concentration. You can perform other tasks while you are seeing, but you can't think about something else while you are working on a problem.
>
> … If we're all so bad at thinking, how does anyone get through the day? … The answer is that when we can get away with it, we don't think. Instead we rely on memory. Most of the problems we face are ones we've solved before, so we just do what we've done in the past. … For the vast majority of decisions we make, we don't stop to consider what we might do, reason about it, anticipate possible consequences, and so on.

In explaining what he means by "memory," Willingham provides,

> All of the information in long-term memory resides outside of awareness. It lies quietly until it is needed, and then enters working memory and so becomes conscious. … Thinking occurs when you combine information (from the environment and long-term memory) in new ways. That combining happens in working memory. (p. 14)
>
> … One of the factors that contributes to successful thought is the amount and quality of information in long-term memory. (p. 22)

Willingham explains what "working memory" is – it is conscious thought, and the "lack of space in working memory is a fundamental bottleneck of human cognition." (p. 109)

> [T]hinking entails combining information in working memory. Often the information provided in the environment is not sufficient to solve a problem, and you need to supplement it with information from long-term memory. … Working memory has limited space, so thinking becomes increasingly difficult as working memory gets crowded. (pp. 16-17)
>
> … [P]eople can keep only so much information in mind at once…. Overloads of working memory are caused by such things as multistep instructions, lists of unconnected facts, chains of logic more than two or three steps long, and the application of a just-learned concept to new material (unless the concept is quite simple). (p. 20)
>
> The phenomenon of tying together separate pieces of information from the environment is called *chunking*. The advantage is obvious: you can keep more stuff in working memory if it can be chunked. The trick, however, is that

> chunking works only when you have applicable factual knowledge in long-term memory. … So factual knowledge in long-term memory allows chunking, and chunking increases space in working memory. (p. 34)
>
> [Willingham] listed four ways that background knowledge is important to reading comprehension: (1) it provides vocabulary; (2) it allows you to bridge logical gaps that writers leave; (3) it allows chunking, which increases room in working memory and thereby makes it easier to tie ideas together; and (4) it guides the interpretation of ambiguous sentences. … [Y]ou should know that much of the time when we see someone apparently engaged in logical thinking, he is actually engaged in memory retrieval. (pp. 36-37)

He sums up his first chapter with the following:

> For problems to be solved, the thinker needs adequate information from the environment, room in working memory, and the required facts and procedures in long-term memory. (p. 18)
>
> The core idea in this chapter is that solving a problem gives people pleasure, but the problem must be easy enough to be solved yet difficult enough to take some mental effort. Finding this sweet spot of difficulty is not easy. (p. 22)

Much of his book proceeds to examine how teachers can help students develop long-term memory sufficiently so that the working memory is not overloaded, and so transfer can more readily take place. Designing curricula with the following strategies in mind, should help students comprehend and apply what's learned.

- Willingham discusses tying learning to emotions as one way to improve memory retention. (p. 57)
- "Repetition is another obvious candidate for what makes learning work." (p. 58) Willingham devotes a chapter to drilling – chapter 5. Being a master of Hapkido, I can unequivocally inform the reader that drilling is indispensible if one wishes to become proficient enough to defend oneself. However, drilling is mundane and difficult to maintain motivation in students. Therefore it is imperative that only that which is indispensible and contributes to the building blocks of education should be subjects of drilling.
- He also points out that "memory is the residue of thought." (p. 61) So thinking about what one learns plays a role in memory retention. The lack of principles being taught in math classes is the reason why people typically do not truly understand the math they learn, but, rather, simply memorize procedures. If one learns principles and then applies them to problems – that is, they think it through – the math at issue is then comprehended and becomes the "residue" or part of one's memory.
- Teaching style is also an important ingredient. "[T]he teacher has a way of interacting with students that they find engaging." There are teachers who make "boring material interesting, and each is able to get students to think about

meaning. … The emotional bond between students and teacher … accounts for whether students learn. … They are able to connect personally with students, and they organize the material in a way that makes it interesting and easy to understand." (pp. 64-65)

- "[O]rganizing a lesson plan like a story is an effective way to help students comprehend and remember." (p. 67)
- Mnemonics help students memorize material. (p. 77)
- Attention grabbers can be a good way to hook the attention of students. (p. 80)
- Analogies – and the more the better – are very important since "new things are understood by relating them to things we already understand. … Examples help not only because they make abstractions concrete. Concrete examples don't help much if they're not familiar. … So it's not simply that giving concrete examples helps. … It's not the concreteness, it's the familiarity that's important; but most of what students are familiar with is concrete, because abstract ideas are so hard to understand." (pp. 89-91) Therefore, it cannot be doubted that applied examples are more readily comprehended because the senses come into use and it is through the senses we more readily comprehend things since we are designed for the real world rather than a world of abstractions.
- "Treat failure as a natural part of learning. … Try to create an … atmosphere in which failure … is neither embarrassing nor wholly negative. Failure means you're about to learn something. You're going to find out that there's something you didn't understand or didn't know how to do." (p. 184)
- "When it comes to teaching, I think of it this way: The material I want students to learn is actually the answer to a question. *On its own, the answer is almost never interesting.* But if you know the question, the answer may be quite interesting. … But I sometimes feel that we, as teachers, are so focused on getting to the answer, we spend insufficient time making sure that students understand the question and appreciate its significance." (p. 75)

To this last point, think of the Egg of Christopher Columbus.[33] The answer to this problem is simple so it provides no joy unless the problem is posed in a challenging way.

Willingham's 4th chapter offers the question with his title *Why Is It So Hard for Students to Understand Abstract Ideas?*. He starts the chapter with an anecdote about a child comprehending a geometry problem in the context of one scenario – determining the area of a table – but when another scenario was presented – the area of a soccer field – he was unable to transfer the principles he learned a short time earlier. Of course, math is all about relationships, but the boy saw no geometric relationship between a table and soccer field so transfer did not occur. He was only able to see the surface structure but not the deep structure of what he learned – the perennial problem with what educators expect from students. However, the problem is neither students' nor abstract concepts'; it's educators' expectations of deep learning from novices when it has been amply demonstrated that this can only be achieved by extensive practice and exposure – i.e. the

[33] https://en.wikipedia.org/wiki/Egg_of_Columbus

realm of experts. However, while students cannot be experts, they can gain more than a shallow understanding through many of the tactics Willingham provides in his book.

Let me deviate from Willingham's question for a moment: Perhaps our educational culture focuses too much on the subject matter being taught and not enough on the concept of discovering – amongst other fundamental principles – correlations in the world. An understanding of correlations has profound implications for citizens in a free society when we consider how sophists misrepresent social challenges in order to push their agenda. With a shallow understanding of correlations, individuals are limited in their ability to see close versus far correlations. For example: If a comet flew overhead, outside our atmosphere, the day a person died, one can say there was a correlation since the two events happened at the same time. However, one cannot say that the cause of an individual's death was due to the comet's presence alone. Therefore the cause of the death cannot be correlated with the presence of the comet. While this example is an obvious one, correlations that are not so obvious can confound people.

Back to Willingham's question *why is it so hard for students to understand abstract ideas*? He answers,

> The challenge is that the mind does not care for abstractions. The mind prefers the concrete. … We understand new things in the context of things we already know, and most of what we know is concrete. Thus it is difficult to comprehend abstract ideas, and difficult to apply them in new situations. The surest way to help students understand an abstraction is to expose them to many different versions of the abstraction…. (pp. 87-88)

This demonstrates why an applied education program is so important. The current system teaches in the disconnected abstract realm but the mind is designed for real world scenarios.

Willingham analyzes the practice of teaching to standardized tests, which frustrate teachers since it ties their hands. He states, "It is too often true that standardized tests offer little opportunity for students to analyze, synthesize, or critique and instead demand the regurgitation of isolated facts." He then makes an important point that "trying to teach students skills such as analysis or synthesis in the absence of factual knowledge is impossible. … Factual knowledge must precede skill. The implication is that facts must be taught, ideally in the context of skills…." (pp. 25-26) Foundational literacy and numeracy skills are where this principle is most applicable. That is, these foundational skills can be thoroughly learned in the context of applied skills.

If this is so, and I believe it is, it then becomes imperative that we determine what is absolutely necessary for students to learn and separate it from superfluous information. Regarding superfluous information, we can teach students how to find/research information/data in such places as pocket references, dictionaries, encyclopedias, etc. We need to separate the chaff from the wheat. To my knowledge, no one has yet taken on this

task, but it is one of the purposes of the Applied Education Foundation and it is an absolute must if we are to pursue equity in a free society.

Willingham quotes J. D. Everett "There is a great danger in the present day [1873] lest science-teaching should degenerate into the accumulation of disconnected facts and unexplained formulae, which burden the memory without cultivating the understanding." (p. 26) "Our goal is not simply to have students know a lot of stuff – it's to have them know stuff in service of being able to think effectively." (p. 48)

Integration & Implementation

Integration

Johanes, (American Society for Engineering Education, 2018) analyzes the requirements in STEM fields to discuss "cross-pollination" of these disciplines. His focus is on materials science and engineering in order to simplify his exploration. Johanes points out:

> These fields require pulling together from a variety of disciplines…. After all, when teaching how to design a robot and assessing a resulting design, the methods and standards from a single discipline would not suffice. Furthermore, as research into increasingly complex phenomena requires more complex combinations of these disciplines, preparing STEM students for navigating these collaborations becomes an important learning objective.

Of course, what Johanes offers as it relates to materials science and engineering, transfers to all fields in the real world, but academicians have resisted recognizing this truth since it complicates their responsibilities – or it reveals their inadequacies which is embarrassing to them.

Johanes uses the term *integrative pluralism* defined as "the philosophical framework to help navigate how to work with the knowledge standards and practices of multiple disciplines."

"Materials science and engineering is an inherently multidisciplinary endeavor. Researchers, practitioners, and students study the fundamental properties of materials [typically done by materials scientists] and the processes used to create and control those properties [typically done by engineers]." Historically, STEM disciplines, like most disciplines in academia, are guarded from each other in order to justify their value and existence.

Johanes compares two perspectives on how "knowing" might be explained. He reflects on the differences between knowing as:

1. If one considers learning to be the construction of mental representations of knowledge that transfer from one context to another…, then knowledge might be defined as units of encodable and retrievable information. The assessments

> of one's learning (defined in this way) might then center on demonstrating the appropriate encoding, retrieval, and transfer of that information beyond the conditions of initial learning.

compared to:

> 2. However, if one redefines learning from constructing a stable knowledge structure to acquiring and activating a task-appropriate set of cognitive and epistemological resources, then transfer across contexts is no longer the most relevant way to view learning and assessment. … The idea here is that learners acquire these resources usually through experience in the world and then instruction is a matter of activating the right set of resources to any particular situation. One could have all of the prior knowledge necessary to solve a particular physics problem, but if one activates resources that frame the problem in a manner that does not render it amenable to be solved using the prior knowledge, then the prior knowledge might as well not have been there. Learning here is recognizing the demands of the task and activating the right resources – it is more about knowing as an event (to be experienced) rather than about knowing as a structure (to be constructed). These two examples from the transfer literature demonstrate the linkages between knowing, learning, and analytics, and that knowing is not an objectively defined or agreed-upon term.

Johanes goes into greater detail on his analysis:

> Since the main thrust of this paper is about designing, navigating and planning instructional and assessment activities, the knowledge-learning-instruction (KLI) framework developed out of the *knowledge tracing* literature serves as a productive starting point. The KLI framework differentiates between observable events (instructional events and assessment events) and unobservable events (learning events). Therefore, moves by an instructor (instructional events) aimed at producing learning (learning events) set up moments during which the learner demonstrates knowing (assessment events). The learning that occurs as a result of an instructional event can only be inferred from the learner demonstration in an assessment event. … This means that when planning instruction, instructors create demonstration-based learning objectives…, which relate to knowledge components…, from which they then design the necessary instructional and assessment activities. This focus on demonstrable learning objectives and aligning the learning objectives with assessment activities is a major contribution of the *knowledge modeling* and *knowledge tracing* literature to curriculum design. [Emphasis added]

This raises the question: Should instruction and assessment be, in large part, so intermingled as to be indistinguishable? That is, if instruction is predominately designed where demonstration by the instructor requires the participation of students, the completion of the task or assignment demonstrates the acquisition of the sought-after

knowledge? In many cases, the necessary data or raw facts of applicable disciplines can be incorporated into the demonstration/participation with tools such as reference works. Of course, most academicians believe the data contained in reference works ***is*** the knowledge students are supposed to acquire (they mistakenly believe such data will automatically be recalled wherever and whenever needed) and therefore their assessments are designed to measure such acquisition; but here lies the fundamental problem of contemporary education. Data acquisition and retention should not be the primary goals of education; it's the use and application of data, joined with experiences, to the real world that matters. So, if an individual has an encyclopedic mind, yet does not know how to apply the stored information (i.e., cannot transfer what's been learned), the data is useless. Whereas, the individual who (though weak in memorization but talented in reasoning) knows where to find information in reference works, is at a tremendous advantage over his academically talented counterpart who can recall all the data academicians prize so much.

Implementation

The medical profession is a good case study for the foundational underpinnings of an applied education system. It is a good example of utilizing academic knowledge – in particular, scientific theory – but with a heavier emphasis in hands-on, real-world application. The stakes couldn't be higher, so the medical profession does what it can to be as effective as possible in practicing its trade. This is only possible with an applied education system. It is far from perfect (consider how ignorant most physicians are to the curative effects of a highly refined understanding of diet and nutrition), but it is, far and above, superior to the current public school culture.

The National Academies of Science (NAS, 2022) published a paper covering the subject of health professions education. They advance educational concepts found in the field of *implementation science*. NAS asks and answers the question:

> "What is implementation science?" … [There are] two ways of understanding the concept. Implementation science was defined by Eccles and Mittman as the "scientific study of methods to promote uptake of research findings in real-world practice settings to improve quality of care." This idea of implementation science stemmed from the world of medicine, public health, and behavioral health to bridge the gap between research and practice. Another way of understanding implementation science is to view an intervention or practice (e.g., pedagogy) as the "thing," implementation strategies as "the ways that we do the thing," and implementation science as a way of measuring outcomes to evaluate how well people or institutions are "doing the thing." … [W]hile traditional research looks at whether a practice is effective, implementation studies take this one step further and examine what specifically makes the practice work; what are the characteristics of the context, the infrastructure, and the process that make it work? (pp. 5-6)

Implementation Science Terms

- *Efficacy studies* test relationships among variables in a tightly controlled laboratory setting.
- *Effectiveness studies* introduce the intervention into a real-world setting to see if it would work in the environment where it might be used.
- *Fidelity* examines how closely a practice or program can be implemented to the way it was intended or designed.
- *Implementation research* identifies core components of an intervention so it can be generalized and modified to other contexts while maintaining effectiveness.
- *Implementation science* is the process of translating information from effectiveness studies into real-world use.
- *Traditional research* studies whether a practice is effective.

… [T]he differences between traditional effectiveness studies and implementation studies: If a study looked at an intervention that was delivered in classes with different teachers, traditional research would treat the different teachers as variables to be controlled so the effect of the intervention could be isolated. Conversely for implementation science, these variables are the object of study; research would attempt to identify differences between the teachers in order to determine if a certain way of delivering the intervention was associated with better student outcomes. This type of research can identify core components of the intervention so it can be generalized and modified to other contexts while maintaining effectiveness.[34]

There are a huge number of outcomes that can be considered in implementation science…. Implementation outcome measures … include acceptability by students and faculty, rate of adoption, whether the practice or program is appropriate for the context, the cost and feasibility of the practice or program, how far the practice or program spreads, and whether it is sustainable over time. [O]f implementation outcomes, *fidelity* is a particularly important one. Fidelity refers to how closely a practice or program can be implemented in the way it was designed. Many people want to modify a program to fit their context, but most of the time it is unknown which components of the program are critical for it to be effective and which ones can be adapted.

Student outcomes of interest include knowledge gain, self-efficacy, motivation, and critical thinking, problem solving, and decision-making skills. In [occupational] education, … student outcomes will ultimately affect [application] outcomes, which can be evaluated using measures of efficiency, safety, effectiveness, [stakeholder] centeredness, and timeliness. While these are not the

[34] A good example of this is occupational education that uses core disciplines, such as math and science, in a context relevant to the occupation. This has been sufficiently demonstrated as a far more effective instruction method when compared to the standard "memorize for the test" instruction methodology that currently dominates public education.

> outcomes that implementation science directly focuses on, the thought is that implementation of a practice or program will affect the knowledge and skills of students, which will in turn affect outcomes for [interested parties such as patients, clients, customers, employers, etc.]. (pp 7-8)
>
> … Many educators are subject matter experts in the area they teach, but they are not experts in pedagogy. While there is research on effective practices in teaching, there is not widespread uptake of these practices among educators. This gap between research and practice is similar to the gap between medical research and routine clinical practice; there is an oft stated statistic that it takes 17 years for a research finding to make its way into clinical practice. Implementation science can help close this gap by identifying best practices and studying ways to successfully implement them in new contexts. [It was] noted that one silver lining of the COVID-19 pandemic has been an increased attention on the methods and strategies of teaching, owing to the need to quickly pivot and innovate.
>
> To illuminate the process of implementation science, a researcher shared an example from her own work implementing a utility value intervention…. The utility value intervention is a brief essay writing assignment in which students are asked to make explicit connections between course content and their own lives. This intervention has both a theoretical basis as well as evidence of effectiveness in the laboratory and the classroom. The theory is based on the idea that achievement is influenced by two components: the student's expectation of performance, and the subjective value that a student assigns to the task. (pp. 11-12)
>
> … [A] number of important elements in [occupational] education [include]:

- an understanding of information processing (e.g., creating presentations that do not surpass cognitive load thresholds),
- the use of retrieval practice as a learning tool (e.g., quizzes),
- simulation and case-based studies[35],
- facilitating reflection on learning, and
- considering the social context in which learning occurs.

Other strategies referenced by NAS are:

- Problem-based learning: In problem-based learning, there is an emphasis on a real-world scenario that students are working on together, and critical thinking and free discussion are encouraged. Evidence suggests that problem-based learning is associated with:
    1. increased self-directed study skills, recall, and transfer or application of knowledge,
    2. greater motivation to attend class,

[35] These two instructional methods are highly compatible with applied curricula.

3. expressed satisfaction with the course (for students and faculty), and
4. better [application of] skills.

- Reflection: Reflection can be defined as "active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it." The use of reflection in the classroom has been associated with
    1. deeper learning and positive learning experiences,
    2. improved understanding of context and reappreciating the value of [occupational] education, and
    3. transformative learning in decision making.
- Flipped learning: a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment.
    1. It promotes student engagement, increases student satisfaction, improves student performance.
    2. It increases course, quiz, and final exam grades.
    3. Students tend to prefer the in-class focus of hands-on, problem- solving activities [as compared to the traditional lecture-room arrangement].
- Integrative curriculum
- Concept mapping (pp. 14-16)

> One thing that implementation science offers is the ability to collaborate across classrooms and across institutions. The structure of implementation science facilitates the identification and dissemination of best teaching practices; the implementation of new best practices is needed because "we teach the way we're taught" unless there is a pedagogical intervention. Implementation science also offers a terminology and a structure for systematically measuring the variables that educators are interested in knowing more about. (p. 17)

NAS's paper is based on a workshop for the medical profession to discover more effective ways of teaching, student learning, and effectively applying clinical knowledge.

The paper refers to *simulation-based education* (SBE) defined as

> a teaching strategy that complements traditional training with actual patients and enables students and health professionals to learn in ways that eliminate risk…. SBE may also involve working with simulated patients using various forms of technology. SBE is well studied, and evidence suggests that it improves a wide range of outcomes, including psychomotor skills, problem solving, critical thinking, clinical reasoning, judgment, clinical confidence, self-efficacy, motivation, and situational judgement. SBE can be delivered using high-fidelity or lower-fidelity simulation. High-fidelity means the simulation is as close as possible to the intended context (e.g., clinical setting), and lower-fidelity simulations take place in contexts (e.g., the classroom) that are dissimilar to the intended context. (p. 21)

Integration and implementation strategies, as outlined above, offer deeper insight into utilizing highly effective instructional methodologies as compared to the current highly ineffectual instructional methodologies. They take into account the cognitive processes in play in an instructional setting. In this way, efficient and effective outcomes can be pursued for all rather than the goal of effectually marginalizing a majority of stakeholders to benefit the minority as the current system has been optimized for.

Engagement & Motivation

Laak and Aru's *AI and Personalized Learning: Bridging the Gap With Modern Educational Goals* (2024) explains the relevance of engagement and motivation in the learning process:

> Decades of research have shown that learning occurs when the learner's mind is actively engaged in the learning process. Broadly, to activate their minds, learners need to be behaviorally and cognitively engaged in their actions: taking notes while reading, writing summaries, participating in discussions, and solving problems. According to the ICAP framework[36], the more cognitively and behaviorally engaged learners are during learning, the more they learn. Some adaptive learning systems, such as Korbit, promote active learning by alternating instruction with interactive problem-solving exercises, coding exercises, project-based learning, Socratic tutoring, and video lectures. However, a common misconception in the adaptive learning literature is that these systems must incorporate gamification, the application of game design elements such as leaderboards, badges, levels, and points, in non-game settings to increase engagement.
>
> In this context, an important distinction has been made between extrinsic and intrinsic motivation. Extrinsic motivation stems from extrinsic rewards (e.g., badges, points, or even grades), whereas intrinsic motivation is an inherent interest and enjoyment in anticipating and obtaining new information. Decades of research have shown that students must be intrinsically motivated to be engaged for extended periods. Furthermore, direct attempts to control learning outcomes through extrinsic rewards and evaluations typically result in lower-quality motivation and performance. [This last sentence sums up the root problem in the American educational system, which is based exclusively on extrinsic rewards.]
>
> In principle, when designed according to the principles of cognitive psychology, educational games can effectively support intrinsic motivation by directing children's attention to the content and stimuli. Games can give students the freedom to fail, choose their next actions, provide rapid feedback, and often offer social engagement, all of which support learning. For example, adding quests to a foreign language course elicited long-term intrinsic motivation and made the

[36] *The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes*, Chi & Wylie, Educational Psychologist, 2014.

course more enjoyable, challenging, and meaningful. However, the effect of game elements on learner motivation in educational settings varies greatly depending on the specific gamification element.

Firstly, much evidence suggests that rewards, incentives, and competition can decrease intrinsic motivation. For example, a comparison of a social networking site and a gamified learning management system found that gamification increased competition and decreased student collaboration, sharing, and participation. Courses gamified with leaderboards and badges have been shown to lower final exam scores and decrease intrinsic motivation compared to non-gamified classes. An experiment examining the specific effects of individual gamification elements showed that points, leaderboards, and levels did not affect intrinsic motivation and only increased the performance quantity. A meta-analysis found psychological effects of gamification, such as increasing enjoyment, fostering enthusiasm, and satisfying learners' need for recognition while providing no additional benefit and sometimes causing anxiety and jealousy. In summary, some gamification elements, such as leaderboards and badges, may decrease intrinsic motivation while providing no additional benefit.

Secondly, while there is sufficient evidence that gamification impacts learning outcomes, there is a paucity of data on the long-term benefits of gamification applied in educational settings. At the short-term performance level, two recent meta-analyses found a positive medium correlation between gamification and learning outcomes. However, the impact of individual gamification elements on learning has been less studied. One of the more recent meta-analyses showed how including game fiction/storytelling and collaborative social interactions has a small positive effect on behavioral, but not cognitive and motivational, learning outcomes. The second meta-analysis showed large effect sizes when collaboration and quests/missions/modules were included in the intervention and more significant effects when some elements, such as leaderboards and timed activities, were excluded.

Taken together, a scarcity of theoretical foundations marks the application of gamification in education, inconsistent empirical findings, and poor experimental design. In addition, a recent longitudinal study showed that even well-designed educational games may not have sustained benefits for educational goals. Hence, designers of PL technologies need to exercise caution when considering integrating both gamification elements and games into computer-based learning environments. As an alternative to gamification, solid evidence supports active learning methods' effectiveness in eliciting intrinsic motivation and enhancing deep understanding, motivation, and creativity.

Miscellaneous Researchers

Dr. Richard Haier is a neuropsychologist who has performed extensive brain imaging research to better understand the dynamics of cognitive abilities (in particular, as it relates

to IQ and the *g* factor) based on the anatomy and physiology of the brain. He has published numerous research papers in journals. The following is a summary for an article he wrote for Scientific American Mind for their Nov.-Dec. 2009 issue, *What Does a Smart Brain Look Like*, pages 26-33. He looked for differences and similarities in the way various brains perform various tasks. He was looking for the way the brain integrates activity among its anatomical structures. He found that "not all brains work in the same way. People with the same IQ may solve a problem with equal speed and accuracy, using a different combination of brain areas."

He found that "the size of certain brain areas and the efficiency of information flow among them" was directly correlated to individual cognitive abilities – though he always refers to it as "intelligence," a misnomer that needs correction. "Brain structure and metabolic efficiency may underlie individual differences … and imaging research is pinpointing which regions are key players. …Women and men who have the same IQ show different underlying brain architectures."

Haier summarizes the history of IQ tests. He states that psychologists "determined that virtually all tests of mental ability, irrespective of content, are positively related to one another – that is, those who score high on one test tend to score high on the others. This fact implies that all tests share a common factor, which was dubbed *g*, a general factor of intelligence." Does this not demonstrate that the one thing that is unquestionably being tested is the ability to take tests? The real-world does not ask us to test well; it requires us to reason and intuit well. Tests do not measure these requirements as Stanovich (2010) thoroughly explains where he compares algorithmic versus rational thinking (see my paper, *Assessment Testing: Not a Measure of Intelligence, But Certainly the Means to Marginalize Political Participation and Economic Opportunity*, for my analysis of his work).

Haier continues, "The *g* factor is a powerful predictor of success." Academic success, yes, but not real-world success, if we extract the credentialing effect. After all, the most successful people are entrepreneurs who rarely come from the academic community.

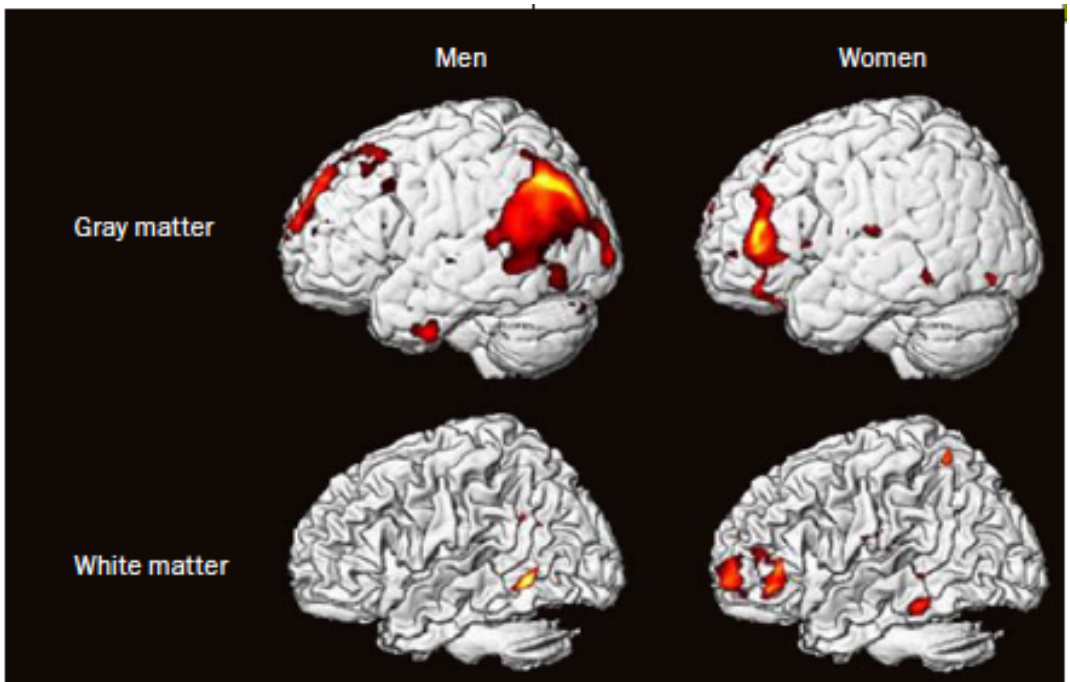
"Using positron-emission tomography (PET), which produces images of metabolism in the brain by detecting the amount of low-level radioactive glucose used by neurons as they fire, we traced the brain's energy use while … volunteers solved … abstract reasoning problems on a test…. To our surprise, greater energy use (that is, increased glucose metabolism) was associated with *poorer* test performance. [Good test takers] were using less energy to solve the problems – their brains were more efficient [at taking tests].

"… In 1992 we used PET before and after subjects learned the computer game Tetris (a fast paced visuospatial puzzle), and we found less energy use in several brain areas after 50 days of practice and increased skill. The data suggest that over time the brain learns what areas are not necessary for better performance, and activity in those areas diminishes – leading to greater overall efficiency. Moreover, the individuals in the study with high *g* showed more brain efficiency after practice than the people with lower *g*." Is

this an observation of brain abilities performing better in a 2-dimensional realm (paper and pencil as well as computers) versus a 3-dimensional realm?

"By the mid-1990s we were focusing on efficiency as a key concept for understanding intelligence. But then, in 1995, we discovered a difference in the way male and female brains work, giving us our first clue to what we know today: the concept of efficiency depends on the type and difficulty of tasks involved, and there are individual and group differences in brain function during problem solving, depending on who is doing the thinking." Doe this not contribute to the idea that the *g* factor does not demonstrate intelligence, but rather, it demonstrates that the combination of natural talent and practice for given activities build neuroanatomical structures that provide for effectiveness and efficiencies for those activities.

"… In addition to these experiments showing differences in brain function, brain *structure* also seems to play a role…. [I]n a series of papers … we used structural MRI scans to investigate correlations between gray and white matter volume and scores on intelligence tests. Gray matter, made up of neuron cell bodies, does the computational work of the brain. White matter enables communication among regions of gray matter via axons, brain cells' long, wirelike appendages. Our studies point to a network of areas distributed throughout the brain where more gray or white matter is related to higher IQ scores. The specific areas in this network are different in men and women, suggesting there are at least two different brain architectures that produce equivalent performance on IQ tests.



The structural roots of intelligence may differ by gender. In women higher IQ scores are associated with more gray and white matter in frontal language areas, whereas in men higher IQ correlates with more gray matter in posterior sensory integration areas.

"… The findings support the idea that general intelligence not only arises from gray matter volume but also depends to a large extent on the white matter connections between crucial gray matter areas. More efficient connections allow information to flow faster – and quick processing times seem to go hand in hand with a high IQ." In other words, select innate abilities combined with immersion in an academic culture will determine IQ test performance.

"But IQ scores do not tell the whole story – not even close. Intelligence seems to arise from varying combinations of … brain areas in different people, which may explain each person's individual strengths and weaknesses. The challenges of identifying these patterns are well illustrated by the extremely rare cases of autistic savants.

"… New studies have found correlations between gray matter in certain areas and specific intelligence factors. … We found a positive correlation between scores on the *g* factor and the amount of gray matter in several areas predicted…. And once we accounted for the common *g* factor, we found that gray matter volume in certain brain areas was related to the other specific intelligence factors.

"… Fascinating recent studies show that learning to juggle increases the amount of gray matter in brain areas relevant to motor activity. When the training stops, the additional gray matter disappears." This demonstrates that whatever the task performed, practice is a very large component of ability; and when practice subsides, that ability diminishes. So until we can better understand innate abilities in relation to practice, the concept of "intelligence" must be marginalized.

Haier then concludes: "Because regional gray matter is related to intelligence, can training beyond conventional education approaches be directed at specific brain areas to increase intelligence?" The answer to this question is undoubtedly ***yes***! Applied education provides the means.

Perhaps the results of Haier's research opens a window into the relationship of white and gray matter and how this is related to transfer – close, medium and far. Close transfer may be the result of white matter connecting gray matter (computational) regions at suboptimal levels; medium transfer may be the result of gray matter growing along with white matter corridors; and far transfer may be an optimal expansion and relationship between white and gray matter – a form of neuroanatomical structure maximally developed. A wise man would have a larger number of these highly developed neuroanatomical structures significantly connected to the many other human abilities when compared to most people. This would help explain a more rational way of thinking, where decisions are reasoned through with analysis of pros and cons, in contrast to fast memory and recall abilities of loosely connected raw information that seems to dominate high IQ individuals' way of thinking.

Professor Jordan Peterson (2017) interviewed Professor Richard Haier (author of *The Neuroscience of Intelligence*, 2017 – which is about his neuro-imaging work on intelligence) who studied individual differences in intelligence, in contrast to what, as he stated, differs from cognitive psychologists' efforts to find commonality in the way people learn. He has used brain scanning technology for brain measurements to relate it to individual differences in the search for understanding the various sources in the brain that contribute to "intelligence."

Perhaps "intelligence" should be defined as higher order functions of consciousness – wisdom being the highest order of mental abilities – in contrast to the autonomic nervous system which is subconscious. Since academics have, in large part, defined "intelligence," they have done so in order to maximize their own sense of self-worth. If we were to include various physical abilities, such as athletics, artistry, mechanical, musical, as examples, many would be in the bottom quartile of the distribution.

Peterson discussed the failures of the national Head Start educational program. While there were gains in academic abilities that were observed in grades one and two, all gains in cognitive abilities were lost by grades five or six. He points out that the gains that were evident was related to those who attended Head Start who: graduated from high school; were less delinquent; experienced less teenage pregnancies; and had a higher percentage who went to college, but that's because they were better socialized not because they had been made "intelligent." Perhaps a healthier blend of socialization combined with academic and real-world skills provides for increases in success. Both soft and hard skills are needed for success.

At minute 18:00 both Peterson and Haier reflect on the divide between the academic community and average people. Academics are totally out of touch with most people, which helps explain why they have such difficulty in perceiving other forms of intelligence that don't fit neatly in their preconceived worldview of economic opportunity. One thing that frustrated both Peterson and Haier were the problems people face who have an IQ below 85. They point out how difficult life is for them and that this is around 15% of the population. Peterson even referenced the fact that the military won't accept anyone with an IQ below 83. However, they did want to make the point that "intelligence" is not necessarily associated with many of the human virtues that contributes to human excellence.

One thing to consider is whether or not our educational system is actually contributing to the problem for those in the bottom distribution. If there is 15% of the population whose cognitive abilities are incongruent with academic abilities, yet society still demands they participate in an academic program during their extremely important formative years – with demeaning criticisms and punishments forthcoming for those who rebel – why are we surprised when we see the results of their incapacities in a highly technical industrial economy? Personally, I would be surprised if we didn't see such atrocious results. It is similar to locking them up in jail at age 5 for several hours every day and then releasing them into society at age 18! What does society expect from such a situation? Their interests and talents are frequently ignored by parents and community, so children turn to

video games or TV programs that numb the mind, and when they mature, they may turn to sex, drugs, and unhealthy forms of entertainment to find an escape. When talents are ignored, like unused muscles, they become atrophied. All the human attributes that contribute to a successful life waste away, including the most important thing of all – a moral compass to navigate an unforgiving world.

At minute 23:40, Peterson states the relationship between IQ and learning is more powerful than the relationship between IQ and job performance. Haier responds with pointing out that the quality of teachers and schools barely accounts for 10% of the variance of academic achievement in students. Throwing money at the problem, therefore, will not solve social inequities.

At minute 29:00, Haier speculates what the world would be like if we shift the populations' IQ 15 points to the higher end. He hypothesizes that social inequities might be reduced. However, this contradicts what the Flynn Effect findings reveal.

> The Flynn Effect is the substantial and long-sustained increase in both fluid and crystallized intelligence test scores that were measured in many parts of the world over the 20th century. … Test score increases have been continuous and approximately linear from the earliest years of testing to the present. … The average rate of increase seems to be about three IQ points per decade in the U.S….. In 1987, Flynn took the position that the very large increase indicates that IQ tests do not measure intelligence but only a minor sort of "abstract problem-solving ability" with little practical significance. He argued that if IQ gains do reflect intelligence increases, there would have been consequent changes of our society that have not been observed [such as a] cultural renaissance.[37]

This makes it quite clear that the association of "intelligence testing" with general abilities that lead to success are disconnected. However, since academia controls credentialing and credentials are largely necessary for employment in lucrative careers – certainly careers where status and prestige are coveted – there is a more modest correlation between IQ and economic success than we are led to believe. But until America embraces the more sophisticated educational programs, such as we find in Switzerland, IQ is all the academic community has to fall back on, as disjointed as it is.

At minute 29:40, Peterson uses a couple examples of the negative effects of populations with high IQs. Women with high IQs tend to find men less attractive; a sect of Jews has an IQ level at 15 points higher than the general population but suffer from a host of neurological diseases. He summarizes by stating that it is hard to gain on one front without losing on another, which Haier agreed with, calling it the Social Justice Theory: If you're good at one thing, you have to be bad at another thing to balance it out. This is somewhat analogous with wildlife biologists' theory that predator and prey relationships are balanced slightly in favor of the prey, otherwise a prey species would become extinct. Pronghorn antelope are a good example of a prey species that has physical abilities way

[37] https://en.wikipedia.org/wiki/Flynn_effect

beyond its needs. It runs slightly faster than cheetah since this cat populated the North American continent not that long ago. It is hypothesized that this antelope will eventually lose such running speeds and steer its survival strategies/energies to more useful ends. The owl has incredible hearing; the eagle, incredible eyesight; wolves, incredible smelling for tracking; upland gamebirds, incredible tactile sensitivity to detect approaching predators through ground vibrations, etc. It basically comes down to this: You can't have it all; each person and species can only have certain advantages to provide balance both in the social world and in nature.

At minute 40:00, Haier stated that what he hoped to achieve by writing his book, *The Neuroscience of Intelligence*, is to show that the genetic aspects are not deterministic, it's the opposite, they're probabilistic. Genetics may play a role, but they don't have to be the major player.

Peterson, at minute 44:30, in discussing what can be done to improve human cognitive performance found that nothing in the literature has shown anything that can be done to improve IQ[38] but he points out that IQ declines precipitously as we age, starting in the early 20s, though aerobic exercise and weightlifting tend to preserve fluid intelligence. This may be correlated with the loss, or pruning, of the overabundant white matter during the youthful years. This overabundance is hypothesized to be available for the brain to be molded to whatever environment an individual finds himself in. (see *How People Learn II*, p. 56)

At minute 47:00 Haier discusses some Harvard research done on the brain's functional and structural white matter connections. The MRI imaging shows mapping of the brain and how an individual's brain is interconnected. The paper states that the interconnections are so reliable within a person that they're like fingerprints, and that these fingerprints can predict IQ. It's related to the density of white matter that connects one neuroanatomical area to another. In addition, a number of brain areas appeared to be connected to "intelligence."

At 53:00 minutes into the interview, Haier discussed brain imaging in an attempt to better understand "intelligence." By imaging volunteers' brains during active learning, as well as after mastery had taken place, Haier found that the primary areas of the brain that were associated with cognitive processes were related to language, memory, and attention,

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[38] Jensen (1969, pp. 58-59) discusses "Heritability of Scholastic Achievement" and differentiates scholastic achievement compared to heritability of "intelligence" and concludes that while IQ cannot be increased, scholastic performance can be, and that this will influence scholastic success. Many "other traits, habits, attitudes, and values enter into a child's performance in school besides just his intelligence, and these non-cognitive factors are largely environmentally determined, mainly through influences within the child's family. This means there is potentially much more we can do to improve school performance through environmental means than we can do to change intelligence per se. Thus it seems likely that if compensatory education programs [predecessor to Project Head Start] are to have a beneficial effect on achievement, it will be through their influence on motivation, values, and other environmentally conditioned habits that play an important part in scholastic performance, rather than through any marked direct influence on intelligence per se. The proper evaluation of such programs should therefore be sought in their effects on actual scholastic performance rather than in how much they raise the child's IQ."

which he felt provide the "architecture on which intelligence is built." One may surmise that highly refined linguistic abilities provide the means to understand and express ideas efficiently and effectively, which "intelligence" tests are highly loaded for. Tests are also highly loaded for memory, especially rapid recall abilities. And attention is necessary to accomplish just about anything, be it passive learning or active application of something learned.

While memory abilities are in my humble opinion fixed, linguistic abilities can be improved, even though such abilities differ between people. I think the same can be said for attention. Though it differs between people, it can be improved. When I taught martial arts to children, parents noticed marked improvements in many of them.

In response to Haier's explanation of the three mental attributes that "intelligence tests" rely upon, Peterson pointed out that much of the psychological literature shows that *attention* and *intelligence* are indistinguishable even though we don't think of them as one and the same. What he points out is that one must have a great deal of attentiveness capabilities to learn something and then to do well in written tests. Peterson then pointed out that *conscientiousness* is related to *attention* but not to IQ. Haier then responded stating that more than *attention*, *memory* is more correlated to the *g* factor, as is processing speed.

At minute 58:20, Haier references his research on consciousness and its effect on creativity. He hypothesizes: If one were to use anesthetic drugs to dissociate the brain to cause disinhibition[39], it may be possible to increase creativity. Peterson points out that certain types of dementia have the same effect because so much of brain function appears to be inhibitory.

Peterson brings up some research he did using repetitive *tasks* (referencing Lumosity cognitive games) to see if improvements in specific tasks, that naturally occur when practiced, would have similar results if one practiced a variety of related tasks that could transfer to other measures like spatial IQ tests such as the Raven's Progressive Matrices. But he points out that it never works that way. He states that the general factor of intelligence doesn't seem to be something that can be improved by practice. What he may be observing is the design of the brain to be efficient. The brain tends to retain what is useful to the individual and discard what is not. Studies of the changes in volume of white matter in the various parts of the brain demonstrates this point. (see *How People Learn II*, p. 56)

Another thing missing from Peterson's tests is an analysis of differentiation between merely practicing a game/task and having a good understanding of foundational principles underlying a task. Learning theory and application, so one builds upon the other, would likely have allowed Peterson to observe the transference of skills developed in one task to that of another task. It would have provided connections and

[39] In psychology, **disinhibition** is a lack of restraint manifested in disregard of social conventions, impulsivity, and poor risk assessment. https://en.wikipedia.org/wiki/Disinhibition

meaningfulness to tasks allowing for easy transferability. A great Canadian naturalist, Frank L. Beebe (1914-2008) demonstrates this point.

Beebe had incredible insight into the world of nature. He could piece things together in a complex ecosystem like no one else. When I asked him how he developed such abilities, he attributed it to his work in the Royal BC Museum (called the British Columbia Provincial Museum when he worked there). Besides his responsibilities in creating the museum's dioramas, he was the illustrator for all their wildlife handbooks for the province. For every species of flora and fauna he illustrated, he would study everything he could find on them to create as realistic an image as he was capable of producing. Through his preparations, he discovered the links that connect species to one another, and nature in general, and had a clearer image of their roles and interactions. With this insight, he appeared as a very wise man capable of far transfer abilities anchored in the combination of reason and intuition which were unmatched. Though he was not a scientist (he only finished 11th grade due to hardships during the Depression), the scientists of the museum frequently sought his advice in things that stumped them. I think part of Beebe's intellectual brilliance had to do with the fact that he was not just an armchair naturalist, he was a man of the field. Beebe went on numerous expeditions alone and entirely self-funded. He was a man of nature in nature. The scholarly works he studied combined with his intense immersion in nature is what, I believe, made him such an intellectual powerhouse, demonstrating related undertakings (tasks, as Peterson called them) can accumulate in one's mind and generalize into other related undertakings. Lab type experiments of such complex human activities cannot duplicate real-world undertakings and therefore cannot provide substantive results that are reliable.

Next, Haier discusses some brain imaging research he did on the process of learning – from the very first stages to the level of mastery (see Haier, 1992). He used the game Tetris (a visual, spatial activity requiring fine motor control) where he did the initial PET scanning on his volunteers when they were first learning the game. He then had them practice the game until it was mastered and then did another scan on his subjects. He found that, even though the game was faster and harder, they used less glucose metabolic rate[40].

At 1:03:17 minutes into the interview, Peterson references some of his research from around the same time as Haier's regarding novelty and routinization. He points out: As people first start to learn something novel, the brain uses very large areas throughout both hemispheres, but as they master something, and it becomes routine, they use very small specified portions of the brain. Haier then confirms that the reduction of glucose metabolic rate is associated with less area of the brain being utilized as one progresses in mastery of an activity. Haier references an imaging study done before his Tetris study that correlated glucose metabolic rate with scores on a test of abstract reasoning with high *g* loaded testing (see Haier, 1988). The subjects took the test during imaging to see what brain areas were involved and energy consumed. He found that the better that people

[40] Process through which glucose is oxidized to carbon dioxide and water as a metabolic fuel (i.e. to provide energy). https://www.encyclopedia.com/education/dictionaries-thesauruses-pictures-and-press-releases/glucose-metabolism

performed on tests, the less glucose that was used; indicating the more people master a subject, the less energy that is required to perform a task such as taking a test. This revealed what he referred to as *brain efficiency*, which many studies thereafter investigated. Peterson beautifully summed up the concept with: "It does seem to make perfect sense that expert skill is associated with doing more with less."

At 1:11:00 Haier references brain imaging studies done for Johnson O'Conner Research Foundation which is an occupational assessment company that is not oriented toward IQ or *g*. Their battery of tests identifies cognitive strengths and weaknesses in order to help individuals match their abilities with a complimentary occupation. Peterson stated that "it's hard to do the psychometrics properly with regards to vocational guidance because we don't have a good handle on how to classify jobs into their various subtypes."

This reveals that "intelligence" testing operates in a corner of the social universe and needs to be seen for what it is: a tool that helps people discover what is worthy of their time and energy as well as what is not. The fact that an IQ of 115 and above is required to flourish in a university setting, as Peterson pointed out, demonstrates its utility for only a minority of the population. And even many in this minority may have no use for college.

Haier points out that the work done on vocational testing by Professor John Holland at John Hopkins University was "very powerful."

Professor Jordan Peterson, in collaboration with some colleagues, created a program called Future Authoring. The program asks students to write about their ideal future. "They were asked to specifically describe the type of person they wanted to be, the skills they wanted to attain, and the relationships they wanted to have, among other things. Simply through this guided contemplation, Dr. Peterson's students found themselves feeling like they had more direction in life. They knew what they could do today to start down the path of becoming the person they wanted to be." When Peterson first researched this idea, the results were very impressive.

Fifty minutes and 18 seconds into Peterson's lecture, *2017 Personality 11: Existentialism: Nietzsche Dostoevsky & Kierkegaard*[41], he explains the origins and results of the Future Authoring program.

"In the Business School at the Rotterdam School of Management, we tested around 4000 students through this Future Authoring Program, which helps make a plan for 3 to 5 years into the future – a plan and a counterplan. The *plan* is: what you want to have happen: and the *counterplan* is: what you really do not want to have happen. And then you make a plan to avoid the latter and to move towards the former. We compared their performance to students three years before the study. … Before we started having people do this plan,

[41] https://www.youtube.com/watch?app=desktop&v=4qZ3EsrKPsc

we looked at the ranking of performance based on ethnicity and gender. The top performing people were Dutch national women and they were a minority among the business students and probably a fairly selected minority so maybe that's what accounted for their higher performance. … Then the next highest performing group were Dutch nationals, and then the next highest performing group were non-Western ethnic minority women, and the lowest performing group were non-Western ethnic minority men. There were quite a few people in all those categories …, a solid study. And within two years after doing the Future Authoring program, the non-Western ethnic minority men were outperforming the Dutch women. Their academic performance went up 70% and their dropout rate plummeted. It really looks good for decreasing dropout rates. The reason I am telling you about that is because people make the automatic assumption that ethnic disparities in performance are necessarily a consequence of sociological or political or economic disparity. This was a peer psychological intervention that wiped out the difference completely; and the Dutch women had actually improved slightly over that two-year period as a consequence of doing the program as well. So, the men not only caught up to the women the way they were performing before, but even better than the way they [women] were performing in the aftermath of having a plan. So, our provisional theory is, we've replicated that in a couple of places, and it works better for men. That's partly because women are already doing well. But we have a hypothesis that men are ornery enough so that unless they have their own plan, they just won't perform. I think it's associated with disagreeableness but we don't know that for sure because we haven't been able to disentangle that, but it's been a very striking finding."

Dr. Robert Sternberg is a cognitive psychologist who developed the Triarchic Theory of Human Intelligence and created his own intelligence test named Sternberg Test of Mental Abilities, due to his own poor performance on intelligence tests during his elementary school years.

Dr. Sternberg's Triarchic Theory of (Successful) Intelligence contends that intelligent behavior arises from a balance between analytical, creative and practical abilities, and that these abilities function collectively to allow individuals to achieve success within particular sociocultural contexts (Sternberg, 1988, 1997, 1999). Analytical abilities enable the individual to evaluate, analyze, compare and contrast information. Creative abilities generate invention, discovery, and other creative endeavors. Practical abilities tie everything together by allowing individuals to apply what they have learned in the appropriate setting. To be successful in life the individual must make the best use of his analytical, creative and practical strengths, while at the same time compensating for weaknesses in any of these areas. This might involve working on improving weak areas to become better adapted to the needs of a particular environment, or choosing to work in an environment that values the individual's particular strengths. For example, a person with highly developed analytical and practical abilities, but with less developed creative abilities, might choose to work in a field that values technical expertise but does not require a great deal of imaginative thinking. Conversely, if the chosen career does value

creative abilities, the individual can use his analytical strengths to come up with strategies for improving this weakness. Thus, a central feature of the triarchic theory of successful intelligence is adaptability-both within the individual and within the individual's sociocultural context (Cianciolo & Sternberg, 2004).
https://www.intelltheory.com/sternberg.shtml

Here is a list of points I extracted from ***How People Learn: Brain, Mind, Experience, and School***, National Academies of Science, 2000 in order to offer insight into their findings:

1. "Herbert Simon wisely stated, the meaning of 'knowing' has shifted from being able to remember and repeat information to being able to find and use it. More than ever, the sheer magnitude of human knowledge renders its coverage by education an impossibility; rather, the goal of education is better conceived as helping students develop the intellectual tools and learning strategies needed to acquire the knowledge that allows people to think productively[42]…. [H]ow to frame and ask meaningful questions about various subject areas, contributes to individuals' more basic understanding of principles of learning that can assist them in becoming self-sustaining, lifelong learners." (p. 5)
2. "A benefit of focusing on how people learn is that it helps bring order to a seeming [disharmony] of choices. Consider the many possible teaching strategies that are debated in education circles and the media. Figure 1.1 depicts them in a diagram format: lecture-based teaching, text-based teaching, inquiry-based teaching, technology-enhanced teaching, teaching organized around individuals versus cooperative groups, and so forth. Are some of these teaching techniques better than others? … This volume suggests that these are the wrong questions. Asking which teaching technique is best is analogous to asking which tool is best – a hammer, a screwdriver, a knife, or pliers. In teaching as in carpentry, the selection of tools depends on the task at hand and the materials one is working with. … There is no universal best teaching practice. If, instead, the point of departure is a core set of learning principles, then the selection of teaching strategies (mediated, of course, by subject matter, grade level, and desired outcome) can be purposeful. The many possibilities then become a rich set of opportunities from which a teacher constructs an instructional program rather than a chaos of competing alternatives." (pp. 21-23)
3. "[L]earners' tendencies to persist in the face of difficulty are strongly affected by whether they are 'performance oriented' or 'learning oriented.' Students who are learning oriented like new challenges; those who are performance oriented are more worried about making errors than about learning." (pp. 60-61)
4. "To provide a knowledge-centered classroom environment, attention must be given to what is taught (information, subject matter), why it is taught

[42] This has always been the purpose of education. We simply lost sight of this when educational bureaucracies took over.

(understanding), and what competence or mastery looks like. … Learning with understanding is often harder to accomplish than simply memorizing, and it takes more time. Many curricula fail to support learning with understanding because they present too many disconnected facts in too short a time – the "mile wide, inch deep" problem. Tests often reinforce memorizing rather than understanding." (p. 24)

5. "Transfer is affected by the degree to which people learn with understanding rather than merely memorize sets of facts or follow a fixed set of procedures. … Students who only memorize facts have little basis for approaching … problem solving task[s]." (pp. 55-56)
6. "Learners, especially in school settings, are often faced with tasks that do not have apparent meaning or logic. … Attempts to cover too many topics too quickly may hinder learning and subsequent transfer because students (a) learn only isolated sets of facts that are not organized and connected or (b) are introduced to organizing principles that they cannot grasp because they lack enough specific knowledge to make them meaningful." (pp. 56-58)
7. "Students taking regular algebra in a major school system received an average of 65 hours of instruction and homework during the year. In contrast, those taking honors algebra received approximately 250 hours of instruction and homework. Clearly, it was recognized that significant learning takes major investments of time."[43] (p. 58)
8. "Understanding when, where, and why to use new knowledge can be enhanced through the use of "contrasting cases," a concept from the field of perceptual learning. Appropriately arranged contrasts can help people notice new features that previously escaped their attention and learn which features are relevant or irrelevant to a particular concept. The benefits of appropriately arranged contrasting cases apply not only to perceptual learning, but also to conceptual learning." (p. 60)
9. "Transfer is also affected by the context of original learning; people can learn in one context, yet fail to transfer to other contexts. … How tightly learning is tied to contexts depends on how the knowledge is acquired. Research has indicated that transfer across contexts is especially difficult when a subject is taught only in a single context rather than in multiple contexts. … When a subject is taught in multiple contexts, however, and includes examples that demonstrate wide application of what is being taught, people are more likely to abstract the relevant features of concepts and to develop a flexible representation of knowledge." (pp. 62-63)
10. "Knowledge that is taught in a variety of contexts is more likely to support flexible transfer than knowledge that is taught in a single context. Information can

[43] This being the case, we really need to scrutinize if even the 65 hours for regular algebra is appropriate. Since it takes far more time to become proficient at it than the 65 hours allows, we really need to scrutinize what level of knowledge is necessary for the average person. It can be assumed that a full semester of algebra, based upon contemporary modes of teaching, is way beyond the needs of the average person. What might be more helpful is to provide an oversight of what algebra does for us; fundamentally show how it works; and then provide sources of reference that will help individuals find what they need when they need it.

become "context-bound" when taught with context-specific examples. When material is taught in multiple contexts, people are more likely to extract the relevant features of the concepts and develop a more flexible representation of knowledge that can be used more generally." (p. 236)

11. "Since transfer between tasks is a function of the similarity by transfer tasks and learning experiences, an important strategy for enhancing transfer from schools to other settings may be to better understand the non-school environments in which students must function. Since these environments change rapidly, it is also important to explore ways to help students develop the characteristics of adaptive expertise." (p. 73)
12. "A second major contrast between schools and everyday settings is the heavy use of tools to solve problems in everyday settings, compared with 'mental work' in school settings. The use of tools in practical environments helps people work almost error free. New technologies make it possible for students in schools to use tools very much like those used by professionals in workplaces. Proficiency with relevant tools may provide a way to enhance transfer across domains. A third contrast between schools and everyday environments is that abstract reasoning is often emphasized in school, whereas contextualized reasoning is often used in everyday settings. Reasoning can be improved when abstract logical arguments are embodied in concrete contexts." (p. 74)
13. "The transfer literature suggests that the most effective transfer may come from a balance of specific examples and general principles, not from either one alone." (pp. 77-78)
14. "A major goal of schooling is to prepare students for flexible adaptation to new problems and settings. … Many approaches to instruction look equivalent when the only measure of learning is memory for information that was specifically presented. … Opportunities to use knowledge to create products and benefits for others are particularly motivating for students." (pp. 77-78)
15. "One characteristic of experts[44] is an ability to monitor and regulate their own understanding in ways that allows them to keep learning adaptive expertise: this is an important model for students to emulate." (p. 78)
16. "All human learners have limitations to their short-term memory for remembering and for solving problems. Simon and others argued that development means overcoming information-processing constraints, such as limited short-term memory capacity. … There are a variety of well-known strategies that increase remembering…." (pp. 95-96)
17. "[Y]oung children exhibit a strong desire to apply themselves in intentional learning situations. They also learn in situations where there is no external pressure to improve and no feedback or reward other than pure satisfaction – sometimes called achievement or competence motivation." (p. 102)
18. "Model-Based Reasoning: Some attempts to revitalize mathematics instruction have emphasized the importance of modeling phenomena [*using models is an applied technique*]. Work on modeling can be done from kindergarten through twelfth grade. Modeling involves cycles of model construction, model evaluation,

[44] For an analysis of the differences between novices and experts, see Willingham, 2009, chapter 6.

and model revision. It is central to professional practice in many disciplines, such as mathematics and science, but it is largely missing from school instruction. Modeling practices are ubiquitous and diverse, ranging from the construction of physical models, such as a planetarium or a model of the human vascular system, to the development of abstract symbol systems, exemplified by the mathematics of algebra, geometry, and calculus. The ubiquity and diversity of models in these disciplines suggest that modeling can help students develop understanding about a wide range of important ideas. Modeling practices can and should be fostered at every age and grade level." (p. 170)

19. "It is also worth noting that … two other issues that we have discussed in this volume, namely that time on task is a major indicator for learning and that deliberate practice is an efficient way to promote expertise." (p. 173)
20. "Transfer can be explored at a variety of levels, including transfer from one set of concepts to another, one school subject to another, one year of school to another, and across school and everyday, non-school activities." (p. 235)
21. The Council points out that "Bringing real-world problems into classrooms through the use of videos, demonstrations, simulations, and Internet connections…" is highly effective in teaching for transfer. (p. 243)

One of the important topics covered in this work is the issue of expert knowledge and how it differs from the novice. Something Willingham (2009) offers on this subject may provide further insight into why public education is organized around abstract concepts with little connection to application. He states, "We can generalize by saying that experts think abstractly. Remember that in Chapter Four I said that people find abstract ideas hard to understand because they focus on the surface structure, not on the deep structure. Experts don't have trouble understanding abstract ideas, because they see the deep structure of problems." (p. 133) Experts are the ones who design curriculum and since they think abstractly, as Willingham points out, it is logical that they write abstractly as well. Writing in a disconnected abstract manner, is not useful for novices to learn by; therefore it behooves us to not rely exclusively on experts or subject specialists to write curriculum. Others must play a role as well so that the abstract realms do not dominate instruction.

Shortcomings of Present Instructional Philosophy

The National Academies of Science provides insight in shortcomings of current instructional philosophies:

1. "At different points in history, scholars have worried that formal educational environments have been better at selecting talent than developing it."[45] (p. 5)
2. "[S]tudents often have limited opportunities to understand or make sense of topics because many curricula have emphasized memory rather than understanding. Textbooks are filled with facts that students are expected to memorize, and most tests assess students' abilities to remember the facts. … '[U]sable knowledge' is not the same as a mere list of disconnected facts. Experts' knowledge is connected

[45] However, selection that has occurred was optimized for academic domains rather than for social needs.

and organized around important concepts… it is 'conditionalized' to specify the contexts in which it is applicable; it supports understanding and transfer (to other contexts) rather than only the ability to remember." (pp. 8-9)

3. "A common misconception regarding "constructivist" theories of knowing (that existing knowledge is used to build new knowledge) is that teachers should never tell students anything directly but, instead, should always allow them to construct knowledge for themselves. This perspective confuses a theory of pedagogy with a theory of knowing." (pp. 8-9)
4. "It is important to view transfer as a dynamic process…. This active view of transfer is different from more static views, which assume that transfer is adequately reflected by learners' abilities to solve a set of transfer problems right after they have engaged in an initial learning task." (p. 66)
5. "The misconceptions are that teaching consists only of a set of general methods, that a good teacher can teach any subject, or that content knowledge alone is sufficient." (p. 156)
6. "Most people have had quite similar experiences with history courses: they learned the facts and dates that the teacher and the text deemed relevant. … Unfortunately, many teachers do not present an exciting approach to history, perhaps because they, too, were taught in the dates-facts method." (p. 157)
7. "The assumptions that historians hold about significance shape how they write their histories, the data they select, and the narrative they compose, as well as the larger schemes they bring to organize and periodize the past. Often these assumptions about historical significance remain unarticulated in the classroom. This contributes to students' beliefs that their textbooks are *the* history rather than *a* history." (p. 159)
8. "Most people are familiar with only the computational aspects of mathematics and so are likely to argue for its place in the school curriculum and for traditional methods of instructing children in computation." (p. 164)
9. "The purpose of scientific enquiry is not to compile an inventory of factual information…." (p. 183) Yet this is what it has become in so many cases.
10. "[A] commonly held misconception about teaching – that effective teaching consists of a set of general teaching strategies that apply to all content areas." (p. 188)
11. "Many classroom activities stress the importance of memorization over learning with understanding. Many, as well, focus on facts and details rather than larger themes of causes and consequences of events." (p. 235)

Teaching Methods Used by Good Instructors

The National Academies of Science offers effective instructional methodologies:

1. "Teachers in learner-centered classrooms also pay close attention to the individual progress of each student and devise tasks that are appropriate. Learner-centered teachers present students with 'just manageable difficulties' – that is, challenging enough to maintain engagement, but not so difficult as to lead to discouragement. They must therefore have an understanding of their students' knowledge, skill levels, and interests." (pp. 23-24)

2. "Social opportunities also affect motivation. Feeling that one is contributing something to others appears to be especially motivating." (pp. 60-61)
3. "Rather than simply introduce students to sets of facts to be learned, these teachers help people to understand the problematic nature of historical interpretation and analysis and to appreciate the relevance of history for their everyday lives. … The goal … is to help students understand history as an *evidentiary* form of knowledge, not as clusters of fixed names and dates." (pp. 159-60)
4. "Some mathematicians advocate [the] fostering [of] conceptual understanding and … [argue for] what aspects of mathematics are important to know." (p. 164)
5. "Skills, such as the ability to describe a problem in detail before attempting a solution, the ability to determine what relevant information should enter the analysis of a problem, and the ability to decide which procedures can be used to generate problem descriptions and analyses, are tacitly used by experts but rarely taught explicitly in physics courses. … Thus, helping students to organize their knowledge is as important as the knowledge itself" (p. 176)
6. Good "teachers build on the knowledge students bring to the learning situation."
7. Good "teachers attempt to help students develop an organized understanding of important concepts in each discipline."
8. Good "teachers attempt to make students' thinking visible so that ideas can be discussed and clarified, such as having students (1) present their arguments in debates, [and] (2) discuss their solutions to problems at a qualitative level…." (p. 188)

Here is a list of points I extracted from ***How People Learn II: Learners, Contexts, and Cultures***, National Academies of Science, 2018 in order to offer insight into their findings:

Summary

1. While the learner gains knowledge and skills as the brain develops throughout childhood and adolescence, the relationship between brain development and learning is not unidirectional: learning and brain development interact in a reciprocal manner. Learning changes the brain throughout the life span; at the same time, the brain develops throughout the life span in ways that influence learning and are in turn influenced by the learner's context and cultural influences.
2. Memory is not a unitary capacity; it is a set of processes by which a learner reconstructs past experiences and forges new connections among them. … Memory involves reconstruction rather than retrieval of exact copies of encoded mental representations.
3. Conscious learning requires sustained effort. To learn intentionally, people must *want* to learn and must see the value in accomplishing what is being asked of them.

4. Purposefully teaching the language and practices specific to particular disciplines, such as science, history, and mathematics, is critical to helping students develop deep understanding in these subjects.
5. [I]t is now possible to move beyond the idea of an "average" learner to embrace and explain variation among individuals.

Introduction

1. People do not simply collect memories, knowledge, and skills in a linear, incremental fashion – slowly and steadily stashing away bits of information in their heads like a video camera recording images and sounds. … People are not passive recipients of learning.
2. The authors summarize findings on "expert" knowledge from their previous book *How People Learn* (2000) [referred to as *HPL I* throughout this work]:
    - Experts differ from novices in more than just their general abilities (i.e., memory or intelligence) and the use of general strategies. Experts have acquired extensive knowledge that affects what they notice and how they organize, represent, and interpret information in their environments, which in turn affects their abilities to remember, reason, and solve problems.
    - Skills and knowledge must be extended beyond the narrow contexts in which they are initially learned in order for deeper learning to occur.
    - The development of a sense of the application of knowledge – when the knowledge can be used – is an essential component of learning.
    - Learning transfer – the capacity to apply learning in a new context – most likely occurs when the learner knows and understands the underlying general principles that can be applied to problems in different contexts.
    - The construction of conceptual understanding of abstract ideas promotes learning.
    - Learners are most successful at learning and will sustain their own learning if they are mindful of themselves as learners and thinkers (i.e., use a metacognitive approach to learning and instruction). [This leads us to believe that understanding cognitive psychology is an important ingredient in successful studies.]
3. Learning in itself changes the physical structure of the brain, and the changing structure in turn organizes and reorganizes how the brain functions. Thus, different parts of the brain may be ready to learn at different times.

Context and Culture

Social and Emotional Influences

People are willing to work harder to learn the content and skills they are emotional about, and they are emotionally interested when the content and skills they are learning seem useful and connected to their motivations and future goals. Conversely, emotions like anxiety can undermine learning by causing worry, which depletes cognitive resources and activates brain regions associated with fear and escape rather than with academic thinking.

Types of Learning and the Developing Brain – Chapter 3

Basic Types of Learning

In the real world, learning situations almost always involve multiple learning processes and always are influenced by context and by the learner's own characteristics and preferences.

Habit Formation and Conditioning

Habits are behaviors and thought patterns that become engrained and feel fluent in particular contexts. … Both learning and unlearning of habits occur gradually and usually unconsciously, though one can become aware of one's habits and work to reinforce or change them mindfully. Habits tend to be self-reinforcing; because they achieve some short-term goal and are enacted relatively automatically, bad habits especially are notoriously hard to unlearn. Good habits, once established, can grow into rich patterns of behavior that help the learner succeed.

The gradual learning and unlearning of habits follows principles of conditioning, a nonconscious form of learning in which one automatically adjusts one's decisions and behaviors when particular and familiar contextual cues or triggers are present. These decisions and behaviors can be strengthened when they are closely followed by rewards….

People often think that they are in rational control of their behaviors and that they act the way they do because they have made a conscious decision. However, the prevalence of habit-driven acts shows that much of our behavior is not consciously chosen. … Establishing a new, good habit might initially take effort and significant application of will power. … Over time, behaviors need to become automatic, rather than deliberate….

It is easy to be impatient with learners who have not yet instilled successful learning habits, such as listening attentively, creating outlines before writing, or periodically summarizing material that is read, and jump to the conclusion that they are not trying hard to learn. But these habits of learning take effort initially and only gain momentum over time. Once acquired, they can become second nature to the learner, freeing up attentional resources for other, more cognitively demanding aspects of a task.

Observational Learning

Learning by observation allows the learner to add new behaviors to his repertoire while minimizing the costs of trial-and-error learning….

Perceptual and Motor Learning

Different training regimes may accelerate skill training, but there is usually no simple shortcut that will yield skilled performance without long hours of practice; it is doing the activity, not being explicitly instructed, that brings the gains.

… It is easy to forget how dramatically people's perceptions and actions can be changed by experience because once they have changed, the individual no longer has access to the earlier perception. … [O]nce one has learned how to see something, it is hard to

remember what it looked like when one was a novice. Experts may not realize that novices cannot see what they themselves see because it seems so self-apparent to their perception.

Learning of Facts
A single exposure to a striking fact … could be sufficient for a listener to remember and subsequently recall it, though he may forget when and where he learned it.

… Although a fact might be learned in a single exposure or from being told, it is important to note that this apparent efficiency and directness can be misleading. Facts are rarely learned in a single instance, and accurate generalizations are rarely learned from a single example. It is generally only in cases where learners have substantial background knowledge already that one example or one instance of exposure can suffice…. Moreover, a considerable body of research on memory shows that repeated opportunities to retrieve facts strengthen memory, particularly if they are spread over time, location, and learning contexts.

… All of these results are unified by the notion that facts that are placed into a rich structure are easier to remember than isolated or disconnected ones.

Learning by Making Inferences
To make sense of their world, people often have to make inferences that while not certain to be correct, are necessary to move forward.

… Models are powerful tools for making inferences in novel situations….

The primary advantage of model-based learning is that the learner who is equipped with an apt model can make good predictions about new situations that go well beyond the originally experienced situations. [Axioms are models that provide such abilities. Math and science instruction must highly organize axioms in education for this reason; and the virus of postmodern nihilism must be utterly eradicated from education in all its manifestations.]

… [M]odels make it easier for learners to describe, organize, explain, predict, and communicate to others what they are learning.

While experts in virtually all domains see the value of hypothesizing models because they are trying to organize a wealth of observations, sometimes early learners are not as convinced of the value of models because they may seem speculative, indirect, and invisible. [Axioms may fall prey to these perceptions.]

Guided, or assisted, discovery learning is an approach in which the educator provides a level of guidance tailored so that the task is at a level of difficulty that fits the learner. (This approach builds on the notion of the "zone of proximal development," or "sweet spot," proposed by Vygotsky in the 1930s). … This approach allows learners to take ownership of the construction of their own knowledge. Evidence suggests that learners

who engage with these types of learning resources, rather than learning by rote, are more likely to retain the knowledge beyond the original context of instruction.

Prenatal and Lifelong Brain Development and Maturation

The prenatal period is marked by an astounding rate of formation of new neurons, synapses, and myelinated axons – with the result that the brain has more of these structural elements than it needs. This development continues after birth: the brain increases fourfold in size during the preschool years and reaches approximately 90% of adult brain volume by age 6. Beginning in early childhood, this explosion in growth, which continues until adolescence, is the result of the dramatic increase in synaptic connections among neurons (gray matter) and in the myelination of nerve fibers (white matter). [The "pruning" process explains a great deal about individual development and abilities. It raises an important question about the effects public institutional education has on the development of the mind. It is reasonable to assume that the mind is molded for an academic life rather than a life in the real world. This is not recipe for success.]

Although vigorous growth continues, the synapses and neurons are also pruned, a process that continues until after puberty. This pruning occurs in a specific way: the synapses that are continually used during this period are retained, while those that are not used are eliminated (see Low and Cheng, 2006, for more on synaptic pruning). The removal of unnecessary or unused synapses and neurons improves the "networking" capacity of the brain and the efficiency of the cortex. Because this pruning is influenced by environmental factors, the developing child's experiences determine which synapses will be strengthened and which will not, laying a critical foundation for future development and learning. Just as strategic placement and pruning of plants yields a healthy garden, a balance between strengthening of some connections and pruning of others fosters healthy brain development: having more neurons left alive is not a better outcome.

Critical and Sensitive Periods in Development

Landmark vision studies by Wiesel and Hubel (1965) helped to define and differentiate the concepts of critical and sensitive periods for early cognitive development. These studies defined critical periods of development as times in which the brain requires certain environmental stimuli to organize its physical development. The best-known example of a critical period is that for development of vision: without the opportunity for sight during certain periods of infancy, the brain will forever be visually impaired. Sensitive periods are similar to critical periods but less fixed. For example, it is thought that both a loving relationship with a caretaker early in infancy and throughout toddlerhood and early exposure to language are essential for healthy brain development. Yet the boundaries are fuzzier for the developmental time periods in which exposure to strong relationships and good language are essential; the effects of deprivation and possibilities for catching up later are imprecise. There is also mounting evidence that adolescence is a second sensitive period for exposure to high-quality social relationships.

Both critical and sensitive periods influence later development: an interruption (e.g., insufficient or inappropriate stimulation) during these times leads to difficulty (or even inability) to process in the affected domain later in life.

Brain Adaptation in Response to Learning

… [L]earners dynamically and actively construct their own brain's networks as they navigate through social, cognitive, and physical contexts. It has been assumed that brain development always leads the way in cognitive development and learning, but in fact the brain both shapes and is shaped by experience, including opportunities the individual has for cognitive development and social interaction. The reciprocal interactions in learning between the dynamically changing brain and culturally situated experience form a fascinating developmental dance, the nuances of which are not yet fully understood. A person's brain will develop differently depending on his experiences, interpretations, needs, culture, and thought patterns. In addition, features internal to the brain's development and structure will constrain the way a person engages with the world. [This suggests that one's family and community life play a significant role in the shaping of the brain. Negative environments are likely to have a negative influence on the shaping process, unless there is a contrary force that neutralizes the negativity.]

Sharing and Recycling of Neural Tissue

Research has shown that just as multiple types of learning blend in practice, circuits in the brain also combine in diverse ways in different types of learning. One might expect that different types of learning depend on different neutral mechanisms, but seemingly very different types of learning behavior share brain circuitry. For example, the hippocampus is heavily involved in fact and rule learning as well as spatial navigation, but it is also centrally important for statistical learning. This finding may seem surprising, but it is consistent with the fact that the hippocampus is involved whenever learning requires that different events or features be bound together into a single representation. This possibility for combining and recombining circuits is key to adaptation.

… Brain organization through learning is therefore more about the *character or logic* of thought than it is about the modality, such as visual or tactile.

"Tuning" to New Requirements

Second, the brain is sufficiently adaptive that its parts become "tuned," over an individual's life span, in response to needs and experiences. Neuroscientists use the term "tuning" to describe their observation that neural responses are strongest when the stimulation is at an ideal level, as the tones produced by the strings of a musical instrument correspond to their tautness and the position and angle at which they are struck. Neurons become tuned over time to respond in particular ways, based on the kinds of stimuli that have arrived and on how the learner has engaged with these stimuli to build experiences and skills.

Neural tuning, which occurs in response to experience, is part of the reason that individual learners' brains are organized differently. [i.e. *perspective* or *point of reference*. "Tuning" is used by Progressives to indoctrinate students in their collectivist ways.]

Varying Time Frames for Adaptation

The slow evolution of the human brain in comparison with the faster pace of cultural changes suggests that humans' distant evolutionary past may provide hints as to what can be learned with efficiency. … Because of these evolutionary biases, situating material to be learned in relation to the kinds of objects and contexts to which our brains have evolved to attend, such as food, reproduction, and social interactions, may improve learning outcomes.

The final leverage point for change is the individual's ability to change in response to a cultural context. This ability underlies the sometimes striking differences that can be observed in learning trajectories across different cultures. For example, whereas 11-month-old [sic] Efe children living in the Ituri rainforest of the Democratic Republic of Congo can safely use a machete, middle-class 8-year-old children in America are rarely trusted with sharp knives. Learning trajectories are often massively influenced by the expectations and training practices within a community. Individuals are not infinitely adaptive, but the extent to which they can rise to cultural expectations when provided with opportunities and support is impressive.

Evidence of Learning-Related Changes in the Brain Throughout the Life Span

The finding that dramatic brain reorganization takes place throughout early childhood and adolescence clearly has implications for education, but linking developmental neuroscience and human behavior research directly to instructional practice and to education policy is complex. Nevertheless, educators may be able to use some developmental neuroscience findings to improve instructional practice.

… After a pre-pubertal period of cortical thickening (i.e., an increase in the number of neurons and thus the density of gray matter), there is a post-pubertal period of cortical thinning. In general, these processes are the physiological ways in which children's and adults' relationships and opportunities – including learning opportunities – and habits of mind directly shape the anatomy and connectivity of the brain.

… To examine how absence of experience (i.e., a lack of opportunity to learn) influences brain development (and therefore learning), researchers have studied the effects of early deprivation experienced by children exposed to institutional rearing. Neuroimaging studies show that early deprivation of learning opportunities of specific kinds (psychosocial, linguistic, sensory, etc.) leads to a dramatic reduction in overall brain volume (both gray and white matter) and to a reduction in electrical activity.

Evidence of Expertise Development and Changes in the Brain

As people acquire knowledge, there are significant changes in their brain activity, brain structure, or both that complement the rapid increase in processing speed and effort needed to use the acquired knowledge. Changes that can be detected in gray and white matter provide one form of evidence for this connection between knowledge acquisition and brain structure. For example, Draganski and colleagues found increased gray matter in the cortices of medical students who had studied extensively for their exams over a 3-month period, compared with control participants who had not experienced this intensive

study period. Findings like this suggest a bidirectional relationship between learning and brain development: Learning promotes brain development, and brain development promotes learning.

A number of studies have found that experts in particular disciplines (such as sports or music) have an increase in the density of both gray matter (containing neurons) and white matter (containing neurons' connections to other neurons) that connect task-related regions of their brains, in comparison with nonexperts. These changes appear to be associated with long-term training. For example, Bengtsson and colleagues found substantial differences between concert pianists and non-musicians in the white matter architecture of specific cortical areas.

An important point that follows from these findings and is worth reinforcing is that cortical thickness cannot be assumed to be a good measure of expertise, knowledge, and skills. [Data is lacking.]

[A]lthough the brain is able to change and adapt throughout the life span, environmental influences in the early years lay the neural scaffolding for later learning and development. [This justifies the development of certain mental cognitive structures and abilities even though an immediate return on such an investment may not be evident.]

Even the earliest studies comparing young and older adults' neural activation during task performance revealed that older adults recruited different regions than young adults did while performing tasks. Indeed, there are few studies that have found reduced levels of neural activity generally in older adults; most studies have found reduced levels of activity in some regions but increased activity in others. [This suggests a shift with age – an optimization of useful architecture and processing – rather than a decline of abilities.]

Conclusions
Different situations, contexts, and pedagogical strategies promote different types of learning. We saw that many kinds of learning are promoted when the learner engages actively rather than passively….

[S]ynaptic pruning and other neurological developments through adolescence shape and are shaped by the learner's experiences….

… The brain develops throughout life, following a trajectory that is broadly consistent for humans but is also individualized by every learner's environment and experiences. It gradually matures to become capable of a vast array of complex cognitive functions and is also malleable in adapting to challenges at a neurological level.

[These concepts of pruning, etc., helps explain why farmers have historically been highly adaptive and innovative in the physical world – whether in the trades, manufacturing, or agriculture. Farmers are highly prized employees due to their exposure to so much at early periods in their lives and while the brain is building an architecture that gives farmers their awesome powers.]

Processes That Support Learning – Chapter 4

Orchestrating Learning

How do people orchestrate their own learning? Three key ways are through metacognition, executive function, and self-regulation.

Metacognition is the ability to monitor and regulate one's own cognitive processes and to consciously regulate behavior, including affective behavior. …

Executive Function is more frequently addressed by psychologists and neuroscientists and refers to cognitive and neural processing that involves the overall regulation of thinking and behavior and the higher-order processes that enable people to plan, sequence, initiate, and sustain their behavior toward some goal, incorporating feedback and making adjustments.

Self-regulation refers to learning that is focused by means of metacognition, strategic action, and motivation to learn.

Executive Function

The processes in executive function include the abilities to hold information in mind, inhibit incorrect or premature responses, and sustain or switch attention to meet a goal.

Executive function is a focus of intense interest – as well as targeted educational interventions – because impaired executive function is a feature of several conditions that may negatively affect learning, including learning disabilities (both reading and mathematical disabilities); attention deficit/hyperactivity disorder, and autism. … Moreover, recent research suggests that executive function (indicated by behaviors such as paying attention and following rules, for example) may be a better predictor of school readiness and academic achievement that general intelligence. [This indicates that subservient and passive personalities are other traits the system has been optimized for. This helps explain why women graduate high schools and colleges at higher percentages.]

Other work on executive functioning focuses on so-called "intrinsic" executive control, or a person's ability to direct himself, change course when needed and strategize in the absence of explicit rules to follow. For example, one study showed that 9-year-old middle-class children … who spent more time in adult-led activities …, and less time in self-directed and peer-negotiated activities … showed worse intrinsic executive functioning. The researchers concluded that the time these children spent in structured learning activities limited their opportunities to learn to manage themselves in natural and informal learning contexts, which are critical for effective learning in the real world.

Self-Regulation in Learning

The capacity to understand and direct one's own learning is important not only in school but also throughout life. [The capacity to understand and direct one's own learning is the primary purpose of education so that one can do so unaided in the real world. Data and facts of subject matter in school are subservient to this end.]

[There is a growing body of research that highlights] how difficult it is for people to regulate their own learning [metacognition] in formal educational settings and the corresponding value of training to improve this capacity. [Public education is, as currently set up, a contradictory institution to attempt to accomplish metacognitive abilities.]

Memory

Reconstructing Memories

When an individual constructs an experience, a representation of that experience is left behind in the brain that he may be able to draw upon in the future. The representation is not a perfect copy of the world but rather a partial record of the individual's subjective interpretation and perception, which is in turn shaped by prior knowledge, experiences, perceptual capabilities, and brain processes. The processes involved in transforming "what happens" into mental representations are known as encoding. Over time and with sleep, an encoded memory may be consolidated, a process whereby the neural connections associated with it are strengthened and the memory, or representation of the experience, is stabilized, or stored. Retrieval refers to the processes involved in reconstructing memories of past experiences. Retrieval processes are triggered and guided by retrieval cues in the learner's environment (e.g., prompts, questions, or problems to be solved) or in the learner's mind (other thoughts or ideas that have some relationship to the memory).

… However, it is not only complex knowledge and events that must be reconstructed through the processes of memory. Even a simple task such as remembering a short list of words for a short amount of time requires active reconstruction. For example, when people were asked in a 1995 study to listen to short lists of related words, such as bed, rest, tired awake, dream, and snooze, and later recall as many of the words as they could, they were highly likely to recall related words that were not on the list, such as sleep. This study showed that rather than simply reproducing encoded copies of the words, the study participants actively attempted [recalling words though they needed to resort other word representations rather than the original symbols used to identify the idea – e.g. the symbol "sleep" is closely correlated to the ideas used in the list that the words represented].

… The retrieval cues available in a learner's environment are critical for what he will be able to recall, and changing the retrieval context and cueing environment changes what a person expresses at any given moment in time. Thus, if a person fails to remember a fact or skill at a particular time, that does not necessarily mean he does not possess the necessary knowledge. [This is important to remember when analyzing what assessment tests are meant to accomplish. Another way to look at this: Is it acceptable to give someone a failing mark for the test maker's failure to provide retrieval cues relative to that which is being measured? And resorting to the concept of "averages" to justify test makers' failures has been convincingly demonstrated by Professor Todd Rose to be a false idol – i.e., there is no such thing as "an average person." Test makers are detached from the outcomes their tests have on individuals – though this is not entirely true. Test

makers are purposefully and maliciously designing tests to ensure a small percentage excel. What if test makers outcomes were completely dependent upon how many people got a perfect score. It can be imagined, their motivations would flip 180º. But then, academics would hate this since it would restrict their exclusivity and selectivity used to elevate themselves above others.]

There are two related implications of this work for educators and others interested in assessing people's learning. First, undue weight should not be placed on any single assessment of a learner's knowledge and skills. Second, memories are reconstructed more easily in situations that feel conducive and relevant to the content of the memory. The way a learner will retrieve particular knowledge and skills varies with the cues that trigger the reconstruction; the cues, in turn, are partly dependent on the emotional, social, and cognitive state of the learner at that moment. For example, a student who prides himself on baseball skills may have no trouble calling up knowledge of statistics during a game but may draw a blank in a high-stakes math test. [This demonstrates that application is the only true way of knowing if someone is competent. Academic tests only serve academia.]

Working and Long-Term Memory

Working Memory

In practice, working memory is associated with academic achievement, including both math and reading skills. Keeping information temporarily in mind and manipulating it is necessary for key learning tasks such as remembering lengthy instructions or keeping track of a problem being solved, and low working-memory capacity puts children at risk for poor academic progress.

Long-Term Memory

There are three types of long-term memory: procedural, episodic, and semantic. Procedural or implicit memory is unconscious, but the other two involve conscious awareness of past events as episodes in one's individual history (e.g., episodic memory of meeting a friend for the first time) or facts and concepts not drawn from personal experience.

… Although some memories may last a lifetime, all are reworked over time, and most fall victim to disruption and interference and are rapidly forgotten.

… Though many memories of distinct learning episodes persist even into old age, people tend to have increased difficulty in forming memories of new episodes as they age. Normal aging is accompanied by a gradual decline in episodic memory that begins as early as the twenties and accelerates precipitously after the age of 60. This decline is associated with degradation in a key aspect of episodic memory: the ability to anchor or bind an event to one's personal past and to a location. [Are episodic memories closely associated with strong emotions which are so prevalent in youth? If so, the "degradation" of "the ability to anchor or bind an event to one's personal past and to a location" would be associated with the degradation of an emotionally charged mind.]

[On page 80, the section "Helping Children Develop Memory Skills discusses teaching techniques for first graders that had "an enduring change in the children's memory structures."]

[O]lder adults have a bias toward pattern completion: the process by which a partial or degraded memory cue triggers an individual to use other prior knowledge and experiences to reconstitute a complete memory representation.

Binding and pattern completion are likely to be part of the explanation for why older adults are more likely than younger adults to retain the "gist" of an event but not its specific details. … Similarly, older adults are more likely to remember the moral of a story rather than its details and to report general rather than specific details of past autobiographical events. Studies show that declines in the specificity of memory likely begin in middle age, with increases in gist-based memory already apparent by the time an adult is in his 50s. [Academia revels in *specific details*, but the real world of the living favors *gist understanding*. *Specific details* are, more often than not, useful to *specific circumstances*, but *specific circumstances* are unique and therefore are not as common; whereas *general circumstances* have correlations amongst numerous *specific circumstances* – which is the world of *gist understanding*. English Common Law (so well explained by Sir Matthew Hale in his *The History of the Common Law of England*, 1713) reflects this reality.]

… The shift toward gist-based memory with age can lead older adults to be more likely than younger adults to remember the "big picture" or important implications. The shift toward pattern completion also may enable older adults to note connections among events and to integrate across experiences, abilities that often are considered part of the wisdom that is acquired with age.

Knowledge and Reasoning – Chapter 5

Building a Knowledge Base

Knowledge integration is a process through which learners put together different sorts of information and experiences, identifying and establishing relationships and expanding frameworks for connecting them. Learners must not only accumulate knowledge from individual episodes of experience but also integrate the knowledge they gain across time, location, circumstances, and the various formats in which knowledge appears. [This summarizes how application and theory will be used to teach broad and deep ideas. In middle school, cottage industries can be used to teach math and science through the craft and then teach the craft's place in history and then use communications to speak and write about the craft.]

Knowledge and Expertise

When people repeatedly engage with similar situations or topics, they develop mental representations that connect disparate facts and actions into more effective mental structures for acting in the world.

Benefits of Expertise

One of the most well-documented benefits of the acquisition of knowledge is an increase in the speed and accuracy with which people can complete recurrent tasks: remembering a solution is faster than problem solving. Another benefit is that people who develop expertise can handle increasingly complex problems. One way this occurs is that people master substeps, so that each substep becomes a chunk of knowledge that does not require attention. People also learn to handle complexity by developing mental representations that make specific tasks easier to complete. When Hatano and Osawa (1983) studied abacus masters, they found that even without an abacus in front of them, the masters had prodigious memories for numbers and could carry out addition problems with very large numbers because they had developed a mental representation of an abacus, which they manipulated virtually. These abacus masters did not show similarly superior ability to remember or keep track of letters … – tasks that were not aided by manipulating a virtual abacus.

A third benefit is an increase in the ability to extract relevant information from the environment. Experts not only have better-developed knowledge representations than novices have but also can perceive more information that is relevant to those representations. For example, radiologists are able to see telling patterns in an x-ray that appear merely as shadows to a novice. The ability to discern more precise information complements a more-differentiated mental representation of those phenomena. An implication of this ability is that students need to learn to see the relevant information in the environment to help differentiate concepts….

A fourth benefit of acquiring expert knowledge is that it helps people use their environment as a resource. … For instance, a major goal of learning is to develop knowledge of where to look for resources and help, and this is still important in the digital age.

… Finally, acquiring knowledge helps people gain more knowledge by making it easier to learn new and related information. Although some cognitive abilities related to learning novel information decline, on average, with age, these declines are offset by increases in knowledge accumulated through the life span, which empowers new learning. [There are always tradeoffs: When one thing is gained, another thing is lost. It's as if there are limits to what we can store.] For example, in a study of young adults and older adults (in their 70s) who listened to a broadcast of a baseball game, the older adults who knew a lot about baseball recalled more of the broadcast than the young adults who knew less about baseball. This occurred despite the fact that the younger adults had superior executive functioning. [It's analogous to the Tortoise and the Hare story. Young people may be able to store data more readily, like a computer, but older people can find correlations unavailable to younger people, which allows elders to see the bigger picture and therefore see details through different lenses, i.e., understanding the details' applications, which elude youngsters.]

Bias as a Natural Side Effect of Knowledge

As people's knowledge develops, their thinking also becomes biased. But the biases may be either useful or detrimental to learning. The word "bias" often has negative connotations, but bias as understood by psychologists is a natural side effect of knowledge acquisition. Learning biases are often implicit and unknown to the individuals who hold them. They appear relatively early in knowledge acquisition, as people begin to form schemas (conceptual frameworks) for how the world operates and their place within it. These schemas help individuals know what to expect and what to attend to in particular situations … and help them develop a sense of cultural fluency – that is, to know how things work "around here."

… Still other biases refine perception and serve to blur distinctions within categories that are not meaningful while highlighting subtle cross-category distinctions that may be important. For example, very young infants respond equally to phonological contrasts that matter in their language (e.g., "r" and "l" if the baby lives in an English-speaking context) and those that do not matter (e.g., "r" and "l" in a Japanese-speaking context). Over time, infants lose this discriminatory capability. This loss is actually a benefit, reflecting the baby's increasing efficiency in processing his own language context, and is a mark of learning. [Though the academic community salivates over those who master multiple languages. Their adoration is for that which is unnatural and unnecessary. This has the tendency to transmit false signals to the young by motivating them to pursue false idols.]

Biases affect the noncognitive aspects of learning as well. In a variable world, highly stable task environments are not guaranteed and so training to high efficiency may actually create a mindset that makes new learning more difficult, impeding motivation and interest in continuous growth and development. For instance, a person who has learned how to organize his schedule using a specific tool may be reluctant to learn a new tool because of the perception that it will take too much time to learn to use it, even though it may be more efficient in the long run. In this example, it is not that the person is unable to learn the new tool; rather, his beliefs about the amount of effort required affect his motivation and interest in learning. This kind of self-attribution, or prior knowledge of oneself, can have a large influence on how people approach future learning opportunities, which in turn influences what they will learn.

Knowledge Integration and Reasoning

We have seen that building a knowledge base requires doing three things: accumulating information (in part by noticing what matters in a situation and is therefore worth attending to); tagging this information as relevant or not; and integrating it across separate episodes.

Inferential Reasoning

Inferential reasoning refers to making logical connections between pieces of information in order to organize knowledge for understanding and to drawing conclusions through deductive reasoning, inductive reasoning, and abductive reasoning. ["Abductive reasoning is a form of logical inference which starts with an observation or set of observations then seeks to find the simplest and most likely explanation for the

observations. This process, unlike deductive reasoning, yields a plausible conclusion but does not positively verify it." Wikipedia]

… Other inferences that learners make survive beyond the bounds of working memory and become incorporated into their knowledge base. For example, a person who knows both that liquids expand with heat and that thermometers contain liquid may integrate these two pieces of information and infer that thermometers work because liquid expands as heat increases. In this way, the learner generates understanding through a productive extension of prior learning episodes. [This may prove as a good experiment where liquid is spilled on a surface at a given temperature, and then increase the temperature. Students will perceive no change, but when the liquid is placed in a tube with numbered lines drawn on the side, the changes can be observed. This lesson is important in that what we see is not always what is actually occurring. It requires us to think through how we may find a way to perceive change.]

Effective problem solving typically requires retrieved knowledge to be adapted and transformed to fit new situations; therefore, memory retrieval must be coordinated with other cognitive processes. [This is where those with academic talents frequently fall short. While the capacity to retrieve might be excellent, their ability to adapt and transform the retrieved knowledge to fit new situations tends to be lacking. It appears that excellent memory and retrieval capacity requires a great deal of brain "space" and ability, which infringes on the "space" and ability of reasoning capacities. There are always tradeoffs due to our limitations.]

Age-Related Changes in Knowledge and Reasoning
… older adults can compensate for declines in some abilities by using their extensive world knowledge. For instance, medical experts depend less on working memory because they can draw on their expertise to reconstruct only those facts from long-term memory that are relevant to a current need.

… Reasoning ability is a major determinant of learning throughout life, and it is through reasoning, especially in contexts that allow people to pursue their interests, that people develop knowledge throughout their life span.

Strategies To Support Learning
Researchers have explored a variety of strategies to support learning and memory. They have identified several principles for structuring practice and engaging with information to be learned to improve memory, to make sense of new information, and to develop new knowledge.

1. Retrieval practice
2. Spaced practice
3. Interleaved and varied practice
4. Summarizing and drawing
5. Explanations: elaborative interrogation, self-explanation, and teaching.

Strategies for Knowledge Retention

Retrieval Practice

Some evidence shows that the act of retrieval itself enhances learning and that when learners practice retrieval during an initial learning activity, their ability to retrieve and use knowledge again in the future is enhanced.

[A study demonstrated that practicing retrieval after reading text] was more productive than spending the same amount of time repeatedly reading.

Attempting retrieval but failing has also been shown to promote learning. Failed retrievals provide feedback signals to learners, signaling that they may not know the information well and should adjust how they encode the material the next time they study it. [This is hardly understood in the assessment world of test-makers.]

Spaced Practice

Researchers who have compared spaced and massed practice have shown that the way that learners schedule practice can have an impact on learning. Massed practice concentrates all of the practice sessions in a short period of time (such as cramming for a test), whereas spaced practice distributes learning events over longer periods of time. Results show greater effects for spacing than for massed practice across learning materials (e.g., vocabulary learning, grammatical rules, history facts, pictures, motor skills), stimulus formats (e.g., audio-visual, text), and for both intentional and incidental learning. … Cepeda and colleagues found that spaced practice led to greater recall than massed practice regardless of the size of the lag between practice and recall.

Interleaved and Variable Practice

Variable learning generally refers to practicing skills in different ways, while interleaving refers to mixing in different activities. Varying or interleaving different skills, activities, or problems within a learning session – as opposed to focusing on the skill, activity, or problem throughout (called blocked learning) – may better promote learning.

Strategies for Understanding and Integration

Summarizing and Drawing

To summarize is to create a verbal description that distills the most important information from a set of materials. Similarly, when learners create drawings, they use graphic strategies to portray important concepts and relationships. In both activities, learners must take the material they are learning and transform it into a different representation. There are differences between them, but both activities involve identifying important terms and concepts, organizing the information, and using prior knowledge to create verbal or pictorial representations.

… A few studies have suggested that the quality of students' summaries and drawings is directly related to how much they learn from the activities and that learners do these activities more effectively when they are trained and guided.

Developing Explanations

Encouraging learners to create explanations of what they are learning is a promising method of supporting understanding. Three techniques for doing this have been studied: elaborative interrogation, self-explanation, and teaching.

Elaborative interrogation is a strategy in which learners are asked, or are prompted to ask themselves, questions that invite deep reasoning, such as why, how, what-it, and what-if not (as opposed to shallow questions such as who, what, when, and where).

… *Self-explanation* is a strategy in which learners produce explanations of material or of their thought processes while they are reading, answering questions, or solving problems.

… Finally, *teaching* others can be an effective learning experience. When learners prepare to teach they must construct explanations, just as they do in elaborative interrogation and self-explanation activities.

Motivation to Learn – Chapter 6

Motivation is a condition that activates and sustains behavior toward a goal. It is critical to learning and achievement across the life span in both informal settings and formal learning environments. For example, children who are motivated tend to be engaged, persist longer, have better learning outcomes, and perform better than other children on standardized achievement tests. Motivation is distinguishable from general cognitive functioning and helps to explain gains in achievement independent of scores on intelligence tests. It is also distinguishable from states related to it, such as engagement, interest, goal orientation, grit, and tenacity, all of which have different antecedents and different implications for learning achievement.

… Learners tend to persist in learning … when they see the value and utility of what they are learning.

… A sense of competence may also foster interest and motivation, particularly when students are given the opportunity to make choices about their learning activities.

Values

Learners may not engage in a task or persist with learning long enough to achieve their goals unless they value the learning activities and goals.

Interest

Learner's interest is an important consideration for educators because they can accommodate those interests as they design curricula and select learning resources. [This is quite a shift from the early days of the Progressive bureaucratically controlled education system designed around the turn of the last century when the idea of "individuals" as autonomous entities was being challenged by Progressives, whose blinders allowed them to see only the collective community as being valuable.]

… Individual or personal interest is viewed as a relatively stable attribute of the individual. It is characterized by a learner's enduring connection to a domain and willingness to re-engage in learning in that domain over time.

Intrinsic Motivation

Self-determination theory posits that behavior is strongly influenced by three universal, innate, psychological needs – autonomy (the urge to control one's own life), competence (the urge to experience mastery), and psychological relatedness (the urge to interact with, but connected to, and care for others). Researchers have linked this theory to people's intrinsic motivation to learn. Intrinsic motivation is the experience of wanting to engage in an activity for its own sake because the activity is interesting and enjoyable or helps to achieve goals one has chosen. From the perspective of self-determination theory, learners are intrinsically motivated to learn when they perceive that they have a high degree of autonomy and engage in an activity willingly, rather than because they are being externally controlled.

External Rewards

The effect of external rewards on intrinsic motivation is a topic of much debate. External rewards can be an important tool for motivating learning behaviors, but some argue that such rewards are harmful to intrinsic motivation in ways that affect persistence and achievement. [This puts into perspective the failings of the current education regime. Extrinsic rewards are shallow. They may work well for some people, but it is not a good strategy. Whereas intrinsic motivation works for everyone.]

For example, some research suggests that intrinsic motivation to persist at a task may decrease if a learner receives extrinsic rewards contingent on performance. The idea that extrinsic rewards harm intrinsic motivation has been supported in a meta-analysis of 128 experiments. One reason proposed for such findings is that learners' initial interest in the task and desire for success are replaced by their desire for the extrinsic reward. External rewards, it is argued, may also undermine the learner's perceptions of autonomy and control.

Effects of Choice

When learners believe they have control over their learning environment, they are more likely to take on challenges and persist with difficult tasks, compared with those who perceive that they have little control.

… Knowing that one has made a choice ("owning the choice") can protect against the discouraging effects of negative feedback during the learning process, an effect that has been observed at the neurophysiological level.

The Importance of Goals

Goals – the learner's desired outcomes – are important for learning because they guide decisions about whether to expend effort and how to direct attention….

Types of Goals

Researchers distinguish between two main types of goals: *mastery goals*, in which learners focus on increasing competence or understanding, and *performance goals*, in which learners are driven by a desire to appear competent or outperform others (see Table 6-1). [Here lies a comparison between pure motives and ego motives. One seeks betterment for personal advancement and the other for the sense of self-worth others provide him.] They further distinguish between *performance-approach* and *performance-avoidance* goals. Learners who embrace performance-avoidance goals work to avoid looking incompetent or being embarrassed or judged as a failure [interesting that they did not include those who are not interested in what others think about them], whereas those who adopt performance-approach goals seek to appear more competent than others and to be judged socially in a favorable light. Within the category of performance-approach goals, researchers have identified both *self-presentation goals* ("wanting others to think you are smart") and *normative goals* ("wanting to outperform others").

Dweck argued that achievement goals reflect learners' underlying theories of the nature of intelligence or ability: whether it is fixed (something with which one is born) or malleable. Learners who believe intelligence is malleable, she suggested, are predisposed toward adopting mastery goals, whereas learners who believe intelligence is fixed tend to orient toward displaying competence and adopting performance goals. Table 6-1 shows how learners' mindsets can relate to their learning goals and behaviors.

TABLE 6-1 Mindsets, Goals, and Their Implications for Learning

Mindsets	
Fixed mindset—*you are born with a certain amount of intelligence*	Growth mindset—*intelligence can be acquired through hard work*
Goals	
Performance goal—*works to look good in comparison to others*	Mastery goal—*works to learn/ master the material or skill*
Learning Behaviors	
Avoids challenges—*prioritizes areas of high competence*	Rises to challenges—*prioritizes areas of new knowledge*
Quits in response to failure—*expends less effort*	Tries harder in response to failure—*puts forth more effort*
Pursues opportunities to bolter self-esteem—*seeks affirming social comparisons*	Pursues opportunities to learn more—*seeks more problem-solving strategies*

Research in this area suggests that learners who strongly endorse mastery goals tend to enjoy novel and challenging tasks, demonstrate a greater willingness to expend effort,

and engage higher-order cognitive skills during learning. Mastery students are also persistent – even in the face of failure….

Learners' mastery and performance goals may also influence learning and achievement through indirect effects on cognition. Specifically, learners with mastery goals tend to focus on relating new information to existing knowledge as they learn, which supports deep learning and long-term memory for the information. By contrast, learners with performance goals tend to focus on learning individual bits of information separately, which improves speed of learning and immediate recall but may undermine conceptual learning and long-term recall. In this way, performance goals tend to support better immediate retrieval of information, while mastery goals tend to support better long-term retention. Performance goals may in fact undermine conceptual learning and long-term recall. When learners with mastery goals work to recall a previously learned piece of information, they also activate and strengthen memory for the other, related information they learned. When learners with performance goals try to recall what they learned, they do not get the benefit of this retrieval-induced strengthening of their memory for other information. [This is an example of Enlightenment Natural Law philosophers' position that truth and goodness, as well as falsehoods and evil, are revealed to us through the effects of our actions. In the present case, if a person is driven by academic performance (which is rooted in ego) in contrast to mastery (which is rooted in self-improvement), then the rewards for one's efforts are marginalized.]

Two studies with undergraduate students illustrate this point. Study participants who adopted performance goals were found to be concerned with communicating competence, prioritizing areas of high ability, and avoiding challenging tasks or areas in which they perceived themselves to be weaker than others. These students perceived failure as a reflection of their inability and typically responded to failure with frustration, shame, and anxiety. These kinds of performance-avoidance goals have been associated with maladaptive learning behaviors including task avoidance, and self-handicapping. [This points out how the dominant pursuit of performance-based goals within academia tends to breed a shallow and incompetent group of people, which helps explain the vote of no-confidence in the academic culture. It also helps explain the dysfunctional and maladapted behavior of many academically oriented college goers. While these types of individuals may not like the academic environment, instead of blaming it, they blame the society they live in to vent their anxieties, stresses, and anger. This is probably due to their inability to distinguish between academia and the rest of society.]

The adoption of a mastery goal orientation to learning is likely to be beneficial for learning, while pursuit of performance goals is associated with poor learning-related outcomes. [Much of the academic culture is driven by the performance-driven goals since the way subjects are typically taught, very little self-improvement is realizable. Because of this, academia tends to marginalize the mastery-driven goals-oriented person. Mastery oriented people must therefore blaze their own trails.]

TABLE 6-2 Achievement Goals and Classroom Climate

Climate Dimension	Mastery Goal	Performance Goal
Success Defined as…	Improvement, progress	High grades, high normative performance
Value Placed on…	Effort/learning	Normatively high ability
Reasons for Satisfaction…	Working hard, challenge	Doing better than others
Teacher Oriented toward…	How students are learning	How students are performing
View of Errors/Mistakes…	Part of learning	Anxiety eliciting
Focus of Attention…	Process of learning	Own performance relative to others
Reasons for Effort…	Learning something new	High grades, performing better than others
Evaluation Criteria…	Absolute, progress	Normative

SOURCE: Adapted from Ames and Archer (1988, Tbl. 1, p. 261).

Influence of Teachers on Learners' Goals
… A mastery-oriented structure in the classroom is positively correlated with high academic competency and negatively related to disruptive behaviors.

… Table 6-2 summarizes a longstanding view of how the prevailing classroom goal structure – oriented toward either mastery goals or performance goals – affects the classroom climate for learning.

Social and Cultural Influences on Motivation
Cross-Cultural Differences in Learners' Self-Construals
Over the past several decades, researchers have attempted to discern the influence of culture on a person's self-construal, or definition of himself in reference to others. In an influential paper, Markus and Kitayama distinguished between independent and interdependent self-construals and proposed that these may be associated with individualistic or collectivistic goals.

… For example, in cross-cultural studies of academic goals, Dekker and Fischer found that gaining social approval in achievement contexts was particularly important for students who had a collectivist perspective. This cultural value may predispose students to adopt goals that help them to avoid the appearance of incompetence or negative judgments (i.e., performance-avoidance goals). [Here is another example of how the academic culture has been optimized for particular abilities and proclivities. Academia is dominated by collectivists because the education system's structure attracts those who need social approval for their sense of self-worth. The demand for compliance and obedience to authority, regardless of the authority's rightness, and the demand for high grades regardless of the uselessness of the information being studied, demonstrates that

those who require social acceptance are motivated by the education system's unjustified goals.]

Interventions to Improve Motivation
Many students experience a decline in motivation from the primary grades through high school. [This is due to the selectivity and optimization of a narrow field of abilities. If all abilities were respected and provided for, this would not occur. In addition, much of what passes for knowledge, is simply a collage of useless data.]

… One group of interventions to address performance setbacks has focused on exercises to help students shift from a fixed view of intelligence to a growth theory of intelligence. For example, in a 1-year-long study, middle school students attended an eight-session workshop in which they either learned about study skills alone (control condition) or both study skills and research on how the brain improves and grows by working on challenging tasks (the growth mindset condition). At the end of the year, students in the growth mindset condition had significantly improved their math grades compared to students who only learned about study skills.

Conclusions
When learners want and expect to succeed, they are more likely to value learning, persist at challenging tasks, and perform well.

… Advances since the publication of *How People Learn I* provide robust evidence for the importance of both an individual's goals in motivation related to learning and the active role of the learner in shaping these goals, based on how that learner conceives the learning context and the experiences that occur during learning.

Implications for Learning in School – Chapter 7

We saw that there are many types of learning, which are supported by a suite of cognitive processes that the learner needs to coordinate and organize. We examined research on knowledge and reasoning, which indicates that developing expert knowledge brings both advantages and biases and that simple accumulation of knowledge is insufficient for tackling sophisticated learning tasks and approaching novel problems and situations. Finally, we described how an individual's beliefs, values, interests, and identities play an integral role in learning….

… In short, the study of learning is the study of the relationships between learners and their environments.

… A summary of promising approaches in each of the subjects taught in school is beyond the scope of this chapter. Several reports by National Academies study committees have summarized some of the major findings related to learning in the disciplines. These include a follow-on volume to *HPL I* titled *How Students Learn* (National Research Council, 2005) that explored learning in history, mathematics, and science; *America's Lab Report: Investigations in High School Science* (National Research Council, 2006), *Taking Science to School: Learning and teaching Science in Grades K-8* (National

Research Council, 2007), *Adding It UP: Helping Children Learn Mathematics* (National Research Council, 2001b), and *Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity* (National Research Council, 2011b). In the section below, we give a broad overview of learning in the disciplines of mathematics, science, and history drawing on these resources. …

Learning Across the Life Span – Chapter 9

Postsecondary Educational Experiences

Once people complete their compulsory education, they may pursue further education in a variety of settings (e.g., community college, college, university, vocational or technical schools). There are several important differences between K-12 and postsecondary education settings.

First, institutions that educate adults have varied goals. Many academic institutions use prior academic performance and ability to select those they think will succeed and thrive in the academic environment they provide; they do not have responsibility for the success of people whom they do not accept or who do not succeed in their environments. Although there are exceptions, such as adult literacy and retraining programs, for most academic institutions and organizations that are training employees the focus is on recognizing and rewarding talent, rather than raising the performance of those who are struggling. Though academic institutions and educators are increasing their attention to factors that affect their students' performance and persistence (such as adjustment to college life and study skills), it remains true that when students do not perform well in school, colleges are not required to continue to enroll them. In work environments, the outcomes for people who are not able to learn new skills can be even harsher; workers who cannot or will not learn a required skill can expect to be told to look for other employment. These two examples illustrate how vital it is that K-12 experiences prepare students for the developmental demands of [postsecondary education and employment. This requires highly independent and resourceful researching ability. Individuals must be able to be self-motivated and have a high sense of self-direction – things currently not taught in the public system.]

Reflections of Herbert Spencer

I would like to offer a summary of the purpose of this essay with an examination of Spencer's (1860) insight into the psychology of educating youth. It is helpful to see the timelessness of some of the educational issues we face and the suggestions he articulated. Though he had little to work with as it relates to available research, and probably had no statistical data available, I'd say Spencer did an incredible job in laying out some foundational principles to consider when formulating curricula and teaching methodologies.

> Before our educational methods can be made to harmonize in character and arrangement with the faculties in their mode and order of unfolding, it is first

needful that we ascertain with some completeness how the faculties do unfold. … Evidently, therefore, it is not to be supposed that even our most advanced modes of teaching are the right ones, or nearly the right ones.

… [T]hough it is not possible for a scheme of culture to be perfected either in matter or form until a rational Psychology has been established, it is possible, with the aid of certain guiding principles, to make empirical approximations toward a perfect scheme. To prepare the way for further research we will now specify these principles. …

1. That in education we should proceed from the simple to the complex is a truth which has always been to some extent acted upon; not professedly, indeed, nor by any means consistently. … [I]t follows that our teachings should begin with but few subjects at once, and successively adding to these, should finally carry on all subjects abreast – that not only in its details should education proceed from the simple to the complex, but in its *ensemble* also.
2. To say that our **lessons ought to start from the concrete and end in the abstract**, may be considered as in part a repetition of the foregoing. … Thus confounding two kinds of simplification, teachers have constantly erred by setting out with "first principles": a proceeding essentially, though not apparently, at variance with the primary rule; which implies that **the mind should be introduced to principles through the medium of examples**, and so should be led from the particular to the general – from the concrete to the abstract. [Emphasis added]
3. The education of the child must accord both in mode and arrangement with the education of mankind as considered historically; or in other words, the genesis of knowledge in the individual must follow the same course as the genesis of knowledge in the race.[46]
4. [I]n each branch of instruction we should proceed from the empirical to the rational. … Science is organized knowledge; and before knowledge can be organized, some of it must first be possessed. Every study, therefore, should have a purely experimental introduction; and only after an ample fund of observations has been accumulated, should reasoning begin. As illustrative applications of this rule, we may instance the modern course of placing

[46] There was an attempt to implement something along this line during the Progressive era, but it was a bizarre concept and it therefore eventually faded away. Spencer touched on genetic inheritance and its influence on learning abilities. The "nature-nurture" argument has been raging since then. I believe the better approach to Spencer's idea is to provide an education based on the evolution of civilizations to better understand the common themes between them and to seek moral lessons from them – judging both the good and the bad in each civilization and to discard hypersensitivity for fear of offending any of them. Also, the evolution of technology as well as the evolution of the various disciplines taught in educational settings would be beneficial in acquiring a deeper and broader understanding of the subjects. The evolution of the subjects taught using inductive reasoning methods will also provide the means to associate the connections between all of them, which will also provide for broader and deeper understanding. And finally, I think Spencer's ideas on teaching youth based on the stage of development they are in (like Piaget) corresponds with his idea of "the genesis of knowledge in the individual."

grammar, not before language, but after it; or the ordinary custom of prefacing perspective by practical drawing.

5. [I]n education the process of self-development should be encouraged to the fullest extent. Children should be led to make their own investigations, and to draw their own inferences. They should be *told* as little as possible, and induced to *discover* as much as possible. Humanity has progressed solely by self-instruction; and that to achieve the best results, each mind must progress somewhat after the same fashion, is continually proved by the marked success of self-made men. Those who have been brought up under the ordinary school-drill, and have carried away with them the idea that education is practicable only in that style, will think it hopeless to make children their own teachers. If, however, they will call to mind that the all-important knowledge of surrounding objects which a child gets in its early years is got without help – if they will remember that the child is self-taught in the use of its mother-tongue – if they will estimate the amount of that experience of life, that out-of-school wisdom, which every boy gathers for himself … if further, they will think how many minds have struggled up unaided, not only through the mysteries of our irrationally planned *curriculum*, but through hosts of other obstacles besides; they will find it a not unreasonable conclusion, that if the subjects be put before him in right order and right form, any pupil of ordinary capacity will surmount his successive difficulties with but little assistance. … This need for perpetual telling is the result of our stupidity, not the child's. We drag it away from the facts in which it is interested and which it is actively assimilating of itself; we put before it facts far too complex for it to understand, and therefore distasteful to it; finding that it will not voluntarily acquire these facts, we thrust them into its mind by force of threats and punishment; by thus denying the knowledge it craves, and cramming it with knowledge it cannot digest, we produce a morbid state of its faculties, and a consequent disgust for knowledge in general; and when, as a result partly of the stolid indolence we have brought on, and partly of still continued unfitness in its studies, the child can understand nothing without explanation, and becomes a mere passive recipient of our instruction, we infer that education must necessarily be carried on thus. Having by our method induced helplessness, we straightway make the helplessness a reason for our method.
6. As a final test by which to judge any plan of culture, should come the question, – Does it create a pleasurable excitement in the pupils? … Even when, as considered theoretically, the proposed course seems the best, yet if it produce no interest, or less interest than another course, we should relinquish it; for a child's intellectual instincts are more trustworthy than our reasonings. … The repugnances to this and that study which vex the ordinary teacher, are not innate, but result from his unwise system. [U]ntil the pupil has arrived at an age when ulterior motives can be brought into play, and an indirect pleasure made to counterbalance a direct displeasure. With all faculties lower than these, however, the direct gratification consequent on activity is the normal stimulus; and under good management the only needful stimulus. (pp. 119-130)

In offering a basic layout of an educational system, Spencer summarizes it by stating,

> We believe that on examination they will be found not only to progress from the simple to the complex, from the concrete to the abstract, from the empirical to the rational; but to satisfy the further requirements that education shall be a repetition of civilization in little, that it shall be as much as possible a process of self-evolution, and that it shall be pleasurable. (pp. 159-60)

Spencer precedes Jean Piaget and his stages of development in youth:

> For manifestly if the steps in our *curriculum* are so arranged that they can be successively ascended by the pupil himself with little or no help, they must correspond with the stages of evolution in his faculties; and manifestly if the successive achievements of these steps are intrinsically gratifying to him, it follows that they require no more than a normal exercise of his powers. (p. 161)

Spencer offers outstanding advice regarding students' comprehension with the following summarization of individual discovery:

> Any piece of knowledge which the pupil has himself acquired, any problem which he has himself solved, becomes by virtue of the conquest much more thoroughly his than it could else be. The preliminary activity of mind which his success implies, the concentration of thought necessary to it, and the excitement consequent on his triumph, conspire to register all the facts in his memory in a way that no mere information heard from a teacher, or read in a school-book, can be registered. Even if he fails, the tension to which his faculties have been wound up insures his remembrance of the solution when given to him, better than half a dozen repetitions would. Observe again, that this discipline necessitates a continuous organization of the knowledge he acquires. It is in the very nature of facts and inferences, assimilated in this normal manner, that they successively become the premises of further conclusions, – the means of solving still further questions. The solution of yesterday's problem helps the pupil in mastering today's. Thus the knowledge is turned into faculty as soon as it is taken in, and forthwith aids in the general function of thinking – does not lie merely written in the pages of an internal library, as when rote-learned. Mark further, the importance of the moral culture which this constant self-help involves. Courage in attacking difficulties, patient concentration of the attention, perseverance through failures – these are characteristics which after-life specially requires; and these are characteristics which this system of making the mind work for its food specially produces. … [I]n the remark of M. Marcel that "what the learner discovers by mental exertion is better known than what is told to him."
>
> Every one knows that things read, heard, or seen with interest, are better remembered than those read, heard, or seen with apathy. In the one case the faculties appealed to are actively occupied with the subject presented; in the other

> they are inactively occupied with it; and the attention is continually drawn away after more attractive thoughts. Hence the impressions are respectively strong and weak. Moreover, the intellectual listlessness which a pupil's lack of interest in any study involves, is further complicated by his anxiety, by his fear of consequences, which distract his attention, and increase the difficulty he finds in bringing his faculties to bear upon these facts that are repugnant to them. …
>
> It should be considered also, that important moral consequences depend upon the habitual pleasure or pain which daily lessons produce. No one can compare the faces and manners of two boys – the one made happy by mastering interesting subjects, and the other made miserable by disgust with his studies, by consequent failure, by cold looks, by threats, by punishment – without seeing that the disposition of the one is being benefitted, and that the other greatly injured. Whoever has marked the effect of intellectual success upon the mind, and the power of the mind over the body, will see that in the one case both temper and health are favorably affected; whilst in the other there is danger of permanent moroseness, of permanent timidity, and even of permanent constitutional depression. To all which considerations we must add the further one, that the relationship between teachers and their pupils is, other things equal, rendered friendly and influential, or antagonistic and powerless, according as the system of culture produces happiness or misery. Human beings are at the mercy of their associated ideas. A daily minister of pain cannot fail to be regarded with a secret dislike, and if he causes no emotions but painful ones, will inevitably be hated. Conversely he who constantly aids children to their ends, hourly provides them with the satisfactions of conquest, hourly encourages them through their difficulties and sympathizes in their successes, cannot fail to be liked; nay, if his behavior is consistent throughout, must be loved. … Professor Pillans … asserts that "where young people are taught as they ought to be, they are quite as happy in school as at play, seldom less delighted, nay, often more, with the well-directed exercise of their mental energies, than with that of their muscular powers." (pp. 162-66)

Spencer concludes this chapter by pointing out that students who find pleasure in learning become lifelong learners and those who found school toilsome avoided learning once school was over.

As a martial arts master, I find Spencer's advice, given above, well founded. Korean instructors I learned from in my youth well understood the concept of self-mastery of what is taught. They would teach techniques and motions in simple ways and leave it to the student to practice diligently to discover the proper way to perform them. They would give tips here and there in order to provide some guidance, but it was left predominately to the student to self-discover the opportune means of performing a technique. They would even use terms like "It becomes yours."

In concluding his work, Spencer provides an insightful observation of the human condition as designed by Mother Nature:

> There is a given order in which, and a given rate at which, the faculties unfold. If the course of education conforms itself to that order and rate, well. If not – if the higher faculties are early taxed by presenting an order of knowledge more complex and abstract than can be readily assimilated; or, if, by excess of culture, the intellect in general is developed to a degree beyond that which is natural to the age; the abnormal result so produced will inevitably be accompanied by some equivalent, or more than equivalent, evil.
>
> For Nature is a strict accountant; and if you demand of her in one direction more than she is prepared to lay out, she balances the account by making a deduction elsewhere. If you will let her follow her own course, taking care to supply, in right quantities and kinds, the raw materials of bodily and mental growth required at each age, she will eventually produce an individual more or less evenly developed. If, however, you insist on premature or undue growth of any one part, she will, with more or less protest, concede the point; but that she may do your extra work, she must leave some of her more important work undone. Let it never be forgotten that the amount of vital energy which the body at any moment possesses is limited; and that, being limited, it is impossible to get from it more than a fixed quantity of results. In a child or youth the demands upon this vital energy are various and urgent. … Now, that to divert an excess of energy into any one of these channels is to abstract it from the others, is not only manifest *a priori*; but may be shown *a posteriori* from the experience of every one. … Every one knows, too, that excess of bodily exercise diminishes the power of thought…. [E]xcess of activity in one direction involves deficiency of it in other directions. … Hence, if in youth, the expenditure in mental labor exceeds that which nature had provided for; the expenditure for other purposes falls below what it should have been: and evils of one kind or other are inevitably entailed. (pp. 291-94)
>
> [R]esults of over-education, disastrous as they are, are perhaps less disastrous than the results produced upon the health – the undermined constitution, the enfeebled energies, the morbid feelings. Recent discoveries in physiology have shown how immense is the influence of the brain over the functions of the body. (p. 297)

Recent studies reveal Spencer's conclusions of ill mental health that results from too much education is certainly correct. Adolescence is extended way beyond what is natural, and dysfunctional behavior is rampant in our young adults who spend too much time in the educational system. As just one example: Eagan et al. (2016, pp. 8-10) have found that as the demand for more education has increased over a 30-year time span, the emotional health of high school and college age students has "dropped precipitously," with women paying a higher emotional price than men.

Education is not an end in itself, it is merely a means to an end (though lifelong learning is to be pursued with vigor if the spark has not been extinguished by an ill designed

program); and the greater the efficiency in getting there, the better it is for the individual and society.

> Chronic bodily disorder casts a gloom over the brightest prospects; while the vivacity of strong health gilds even misfortune. We contend, then, that this over-education is vicious in every way – vicious, as giving knowledge that will soon be forgotten; vicious, as producing a disgust for knowledge; vicious, as neglecting that organization of knowledge which is more important than its acquisition; vicious, as weakening or destroying that energy, without which a trained intellect is useless; vicious, as entailing that ill-health for which even success would not compensate, and which makes failure doubly bitter. (p. 303)

> Considering the [educational] *regime* as a whole, its tendency is too exacting; it asks too much and gives too little. … Regarded from another point of view, this high-pressure education manifestly results from our passing phase of civilization. In primitive times, when aggression and defense were the leading social activities, bodily vigor with its accompanying courage were the desiderata; and then education was almost wholly physical: mental cultivation was little cared for, and indeed, as in our own feudal ages, was often treated with contempt. But now that our state is relatively peaceful – now that muscular power is of use for little else than manual labor, while social success of nearly every kind depends very much on mental power; our education has become almost exclusively mental. Instead of respecting the body and ignoring the mind, we now respect the mind and ignore the body. Both these attitudes are wrong. We do not yet sufficiently realize the truth that as, in this life of ours, the physical underlies the mental, the mental must not be developed at the expense of the physical. The ancient and modern conceptions must be combined. (pp. 307-08)

As it relates to acquiring expertise in clinical medicine, **Pena** (2010) analyzes the Dreyfus theory of intuition as it relates to learning and expertise. Medical education is an excellent analysis since it is highly correlated with the principles of an applied education program. However, the author makes an important distinction between direct and inverse problem solving: Direct is where there is a known and described prescription for an action; inverse is where the problem must be resolved in the reverse, such as a physician diagnosing an ailment based on symptoms that are complex and ill defined. Perhaps early in an educational experience, the direct model would be most effect – since intuition has not been achieved in the domain – and at the point of early competence, the inverse model should come to dominate training – such as during an internship stage.

Pena states:

> **Abstract**

Context: The Dreyfus model describes how individuals progress through various levels in their acquisition of skills and subsumes ideas with regard to how individuals learn. Such a model is being accepted almost without debate from physicians to explain the ‘acquisition’ of clinical skills.

Objectives: This paper reviews such a model, discusses several controversial points, clarifies what kind of knowledge the model is about, and examines its coherence in terms of problem-solving skills. Dreyfus’ main idea that intuition is a major aspect of expertise is also discussed in some detail. Relevant scientific evidence from cognitive science, psychology, and neuroscience is reviewed to accomplish these aims.

Conclusions: Although the Dreyfus model may partially explain the ‘acquisition’ of some skills, it is debatable if it can explain the acquisition of clinical skills. The complex nature of clinical problem-solving skills and the rich interplay between the implicit and explicit forms of knowledge must be taken into consideration when we want to explain ‘acquisition’ of clinical skills. The idea that experts work from intuition, not from reason, should be evaluated carefully.

Models [which can be correlated with axioms] are conceptual constructs that aspire to represent real things or processes that to a large extent are hidden for the senses and to the ordinary experience. Models have a role to describe, represent, explain, and ‘translate’ the world. Some good examples are the Feynman diagrams of electrodynamic processes, the fluid mosaic membrane, and the DNA double helix. Although models are partial and just approximations to the truth, they are not fictional or conventional at all. They try to represent their referents in a truthful and objective way with the hope to constantly improve or replace them with better approximations or more precise explanations.

Dreyfus and Dreyfus have offered a model of professional expertise that plots an individual’s progression through a series of five levels: novice, advanced beginner, competent, proficient, and expert. In the novice stage a person follows rules that are context-free and feels no responsibility for anything other than following the rules. Competence develops after having considerable experience. Proficiency is shown in individuals who use intuition in decision making and develop their own rules to formulate plans. Expertise is characterized by a fluid performance that happens unconsciously, automatically, and no longer depends on explicit knowledge. Thus, the progression is envisaged as a gradual transition from a rigid adherence to taught rules and procedures through to a largely intuitive mode of operation that relies heavily on deep, implicit knowledge but accepts that sometimes at expert level analytical approaches are still likely to be used when an intuitive approach fails initially.

This model, a product of philosophical deliberation and phenomenological research, was initially adapted by Benner and other nursing educators to explain

the development of nursing skills. However, this was not without debate, which still remains.

… Assuming that nurses' and physicians' skills are of the same nature, physician educators have 'translated' and adjusted such a model to explain clinical skills not only in terms of simple routine tasks but also in terms of the most symbolic skills, i.e., clinical problem-solving skills. Many authors express their support for this. For Daaleman, Dreyfus provides a model of knowledge and skill acquisition that is relevant to the training of physicians in practical wisdom. Batalden, Holmboe and Hawkins recommend assuming Dreyfus' ideas as a framework to understand medical competencies. The Accreditation Council for Graduate Medical Education (ACGME) recommends this model for curriculum planning for residency training programs.

Box 1. Dreyfus's postulates versus alternative propositions

Dreyfus' referents	Referents
1. Cognitive processes and skills in terms of implicit knowledge.	1. Cognitive processes and skills in terms of implicit and explicit knowledge.
2. Brain as a spurious referent.	2. Brain as one of the main referents.
Philosophical background: Phenomenology	*Philosophical background*: Scientific realism
3. Doctrine based on the study of personal experience in which considerations of objective reality are not taken into account.	3. The thesis that there are real things, the world exists independently of the knowing subject.
4. The reality is subject-dependent because a thing is a complex of sensations.	4. The reality can be known objectively and is best explored scientifically.
5. 'The word is the abode of being,' 'things become and are only in the world, in language.' Reality is constituted in and through discourse.	5. Science distinguishes between words and their referents (atoms, stars, people, societies, etc.). This is why science does not study them semantically or discursively but experimentally.
6. Rhetorical style. No citing of scientific evidence to ground their proposals.	6. Models that are representations of real things must be coherent with scientific evidence.
Dreyfus main postulates	*Alternative postulates*
7. Skills are automatic 'dispositions' stored in our minds.	7. Skills are lasting modifications in an individual's brain apart from habituation or memory that enable its owner to face new experiences.
8. Performance of skills is explained exclusively in terms of implicit knowledge.	8. There is not a pure skill that allows only implicit or explicit knowledge to contribute to performance.
9. There are no references to inverse and ill-defined problems.	9. Any model of clinical skills acquisition must recognize that it faces special kinds of problems: inverse and ill-defined.
10. Acquisition of skills of any kind can be explained with this model.	10. A model should be specific for skills of different natures.
11. The acquisition of a skill is viewed as a gradual transition from rigid adherence to rules, to an intuitive mode of reasoning that relies heavily on deep tacit understanding.	11. The acquisition of skill is viewed as a learning process in two ways: suddenly and gradually. All kind of stimuli is necessary to facilitate the trainee's learning, aside from rigidly following rules.
12. A high degree of performance is attained when the individual works intuitively.	12. A high level of performance is attained when somebody is able to work intuitively, reflectively and analytically

Contrary to the debate raised in academic nursing fields, judging by medical publications and recommendations from academic organizations, the current form of Dreyfus' model is being accepted almost without explicit criticism from physicians. Thus, although there may be some debate among clinicians and educators, such a debate is not evident in published papers. The Dreyfus model is reaching out to the educative arena and thus plays an important role in modeling how physicians acquire clinical skills. This may generate important consequences for our education. As was mentioned in this introduction, even models that are born from science are not complete explanations or perfect approximations to the truth, and they might be erroneous. Different from those, the Dreyfus model comes from philosophical fields; this fact makes even more urgent a critical analysis and debate. This paper tries to stimulate both.

Referents

A very important requirement for any model is its referent, i.e., the object or process referred to by the model or that which the latter is about. The Dreyfus model postulates that when individuals acquire a skill through external instruction, they normally pass through several stages. It is undeniable that such a process implies the acquiring of some knowledge. This psychological result of perception, learning, and reasoning constitutes the Dreyfus model's primary referent. Because the acquisition of knowledge does not happen in a vacuum but in a very complex organ (the brain), it is desirable that any hypothetical construct that attempts to explain learning is defined not only psychologically but also neurologically. Unfortunately, neurological terms appear in the model only when Dreyfus gestures toward artificial neural networks to demonstrate that phenomenology[47] can reveal objective structures of bodily praxis.[48] Therefore, we may say that the brain is a secondary or spurious referent of such a model. …

History and scientific evidence

Some historical facts may be also interesting. The original model was not published immediately for public scrutiny. Four prior reports exist from the U.S. Air Force, where some observations carried out on the instruction of jet pilots are described by Dreyfus. In those reports, few original scientific studies were cited and standardized protocols were not utilized. The only recent change in the model is the addition of two stages ('master' and 'practical wisdom') to the five originally proposed.

Philosophy

All models have philosophical roots; Dreyfus' ideas are based on phenomenology, a philosophical doctrine proposed by Edmund Husserl based on the study of personal experience in which considerations of objective reality are not taken into account [i.e., no axioms]. This view opposes scientific realism; for Husserl, the world of things 'is only a presumptive reality,' whereas the subject is

[47] A philosophical movement that describes the formal structure of the objects of awareness and of awareness itself.… Merriam-Webster

[48] Exercise or practice of an art, science, or skill; practical application of a theory. Merriam-Webster

Box 2. Dreyfus' postulates versus alternative propositions

Dreyfus' model stages propositions	Alternative propositions
Novice 1. A novice follows rules. 2. Does not feel responsible for anything other than following the rules. 3. Needs to bring its behavior into conformity with the rules. 4. Learning is free of context. *Advanced beginner* 5. Begins to gain experience in real scenarios. 6. Begins to understand his environment with its contextual features. 7. Learns 'instructional maxims' about actions. 8. Learning still occurs in a detached analytic frame of mind. 9. Does not experience personal responsibility. *Competent* 10. Develops an emotional attachment to the task. 11. Learns 'guidelines' (principles formulated by instructors, which dictate actions in real situations). 12. Competence comes only after considerable experience. *Proficient* 13. Learner uses intuition to realize 'what' is happening. 14. Uses memorized principles called 'maxims' to solve problems and determine the appropriate action. 15. Prior experiences provide patterns for future recognition of similar situations viewed from similar perspectives. *Expert and master* 16. Work intuitively on any problem. 17. No longer needs principles. 18. Capable of experiencing moments of intense absorption in his work.	1. Novices are not passive learners who just follow 'rules.' 2. Novices acquire information that allows them to grasp the nature of skills (understanding is a prerequisite to learning). 3. Novices need freedom. 4. Learning cannot be detached from context. 5&6. Even at the pre-beginner stage, learners gain experience and understanding of context; information, context, and experience cannot be separated. 7. Maxims are a few explicit 'prescriptions' that are learned at any stage. 8&9. There is always an emotional attachment to the task even at novice stages; hence there is always an experience of personal responsibility. 10. Again, affect is always linked to any cognitive task. 11. Learns to solve inverse problems, but those cannot be solved following rules, maxims, or guidelines. 12. Competence comes after learning to solve inverse problems. 13. A proficient learner, although esteeming its intuition, knows that it is not enough to realize 'what' is happening. 14. A 'proficient' performer tries to solve problems in novel and imaginative ways; he does not use only specific 'maxims' because they are just general recommendations. 15. Humans are 'pattern seekers and makers' even at pre-proficient stages. 16. Experts esteem intuition but are far from limited to a passive acceptance of it; experts analyze, critique and elaborate ideas. 17&18. For an expert, intuition only represents a portion of the problem solving process, which is always analytical besides intuitive. Experts need implicit but also explicit knowledge.

the absolute reality. The world is also 'an infinite idea, a complete synthesis of possible experiences.' [Husserl appears to be a postmodernist where "reality" is entirely subjective with infinite "truths."] Thus, the reality is subject-dependent because a thing is a complex of sensations [again, absent axioms]. Moreover, according to Husserl, introspection through ordinary experience rather than through experiment, analysis, and modeling can yield deep knowledge of the world. [Husserl's position is in direct opposition to centuries of philosophical reasoning that has argued that our senses frequently mislead us. Husserl's model is one of trial-and-error and coincidentally stumbling upon truths.] For Martin

Heidegger, another key proponent of phenomenology, 'the word is the abode of being,' and 'things become and are only in the word, in language.' In other words, reality is constituted in and through discourse. [This coincides with Genesis in the Bible as Jordan Peterson explains in his *Biblical Series*; i.e., reality begins to take shape as words describe objects and phenomena – verbal description, brings order out of chaos.] We smell this philosophy in Dreyfus' original work on the model of skill acquisition and we discover his explicit adherence to phenomenology, especially to Heidegger's existential phenomenology, in one of the most authoritative texts on these matters: 'Being in the world: a commentary on Heidegger's ''being and time.'''

Adaptation to clinical medicine

For the medical field, the model has been adapted with minor changes. For example, Dreyfus' main postulates are that the 'immediate intuitive situational response is the characteristic of expertise,' and that most expert performance is ongoing and non-reflective: 'fluid performance happens unconsciously, automatically, naturally,' and 'the expert driver generally knows how to perform the act without evaluating and comparing alternatives.' [Perhaps this provides an analogy to truths: When we see the best choice of alternative choices, we intuitively and automatically choose that which coincides with the best results.] Medical educators have proposed a hybrid model where masters are highly intuitive as well as reflective: 'the master is the practitioner who self-assesses and self-regulates and reflects in, on and for action.' This current statement contradicts the original model. Frequently, it is also stated by physicians that the model postulates that experts use intuition where empirical and propositional knowledge does not yet exist. Actually, the original model was proposed the other way around: experts work intuitively on every problem and only use other types of knowledge in a few cases when intuition fails.

The following paragraphs will discuss the most controversial aspects the Dreyfus model proposes. The main body of this paper will go further about the referents and basically will clarify what kind of knowledge the model is about and will review its coherence with problem-solving skills; some relevant scientific evidence from cognitive science, psychology, and neuroscience will also be reviewed. The central idea of intuition as a major definition of expertise will be discussed in some detail. This is also a good time to advise that this manuscript does not have any intention to be 'ecumenical' [i.e., universal]. Readers interested in favorable opinions and sympathetic papers of the Dreyfus model are urged to read several of the publications included in the references.

Types of knowledge and the Dreyfus model

Because one of the most important referents of the model is knowledge, it would be of some benefit to review that concept. There are many kinds of knowledge and several ways of grouping these kinds into large categories. A division of knowledge that is relevant when analyzing the Dreyfus model is into know-that and know-how. Traditionally, explicit knowledge or 'knowing that' has been

understood as expressible in some languages; it can be attained easily from any codified information. By contrast, 'knowing how,' tacit or implicit knowledge, as it was proposed by philosopher Michael Polanyi, is not expressible in some languages. It is considered intuitive – acquired through practical experience – and as such, is subjective and contextual, and cannot be readily made explicit or formalized. [It may be subjective from an individual's limited subjective perspective, but there is bound to be an underlying human axiom that encompasses all interrelated knowledge or skill. A concept simply hasn't been organized and verbalized yet that summarizes the axiomatic truth, or as Peterson calls them, hyper-realities. "They are more real than what you see. They're more real than the reality that presents itself to you." Metaphors can be used to reveal hyper-realities.] Polanyi also suggested the supremacy of such implicit knowledge: 'While tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is either tacit or rooted in tacit knowledge.'

In psychology, the knowledge gained in implicit learning is defined by using several criteria. It is not fully accessible to consciousness. The learner cannot provide a full verbal account of what he has learned. Implicit knowledge does not involve processes of conscious hypothesis testing. … Implicit knowledge is stored as abstract – and possibly instantiated[49] – representations rather than aggregate or verbatim representations. …

Knowledge that represents its content, attitude, and its holder explicitly is on the higher-order thought theory, conscious, and is considered explicit. Explicit mental representation is required to refer in verbal communication and thus a link emerges between explicitness and consciousness. The explicit processing of knowledge includes perceptual, cognitive, and motor processes, such as stimulus selection and search, attention focusing and maintenance, memorization, computation, decision making, response selection, and execution. …

Although the Dreyfus brothers recognize [the] division [between explicit and implicit] knowledge, they believe that skills are exclusive instances of know-how or implicit knowledge: 'you can ride a bicycle because you possess something called ''know-how,'' which you acquired from practice and sometimes painful experience.' The Dreyfus brothers assert that when we perform a skill, we basically execute implicit knowledge without a connection to explicit knowledge. They believe that skills are automatic dispositions that cannot be readily made explicit. They go further and propose that the net effect of learning is intuition and define it in terms of implicit knowledge: 'when we speak of intuition or know-how, we are referring to the understanding that effortlessly occurs upon seeing similarities with previous experiences. We shall use intuition and know-how as synonyms.' In summary, Dreyfus and Dreyfus define skills at expert level almost exclusively in terms of implicit knowledge.

[49] To represent (an abstract concept) by a concrete or tangible example.

A critical point is to accept whether or not clinical problem-solving skills are implicit in nature or if they are predominantly dependent upon implicit knowledge. As we reviewed above, it is difficult to develop a task exclusively in terms of implicit knowledge. Even more importantly, clinical problem-solving skills are also instances of explicit knowledge. The clearest cases of explicit knowledge of a fact are representations of one's own attitude of knowing that fact. Knowledge capable of such fully explicit representation provides the necessary and sufficient conditions for conscious knowledge. This is the case when a physician evaluates a patient. Although he is not aware of all of the cognitive steps needed to make a diagnosis, he needs to be conscious of at least the following events: characterization of a patient's symptom, valuation of a patient's sign, and solicitation of a diagnostic test. Furthermore, physicians explicitly provide a representation (diagnosis) and express the degree of accuracy or inaccuracy and can judge their representations to be true, false or undecided. Hence, it is reasonable to accept that making a diagnosis also subsumes an explicit dimension of knowledge. Therefore, a model that does not respect the complex and rich interaction between both domains of knowledge will have difficulty explaining skills that are not just routines but instead very complex tasks, i.e., finding solutions to problems.

Inverse problems and clinical problem-solving skills

We will start the discussion of this section by pointing out that there is not only one type of problem, but several types. Most problems can be classified into direct, well-defined problems and inverse, ill-defined problems. Direct or forward problems are of the following type: given C (causes) →E (effects), find E (effects), where (→) symbolizes the causal relationships. These types of problems call for analysis, or progressive reasoning, either from premises to conclusions or from causes to effects. In contrast, an inverse problem is a more complicated problem of the following type: given the clinical data E (effects=symptoms) and the acceptable causal hypothesis $C_1 \rightarrow E$, $C_2 \rightarrow E$, . . ., $C_n \rightarrow E$, find the original cause C. Inverse problems require synthesis, or regressive reasoning, from conclusions to premises or from effects to causes. Inverse problems also are ill-defined problems in the sense that a simple solution may not exist, there may be more than one solution, or a small change in the problem leads to a big change in the solution [hence one cause of relativistic philosophical arguments].

Well-defined and direct problems have a clear path to a solution. The problem may be solved by using a set of recursive operations or algorithms. In contrast, the cognitive processes involved in the solution of ill-defined problems are far more complicated and still ill-understood. In the case of ill-defined problems, all aspects of problem formulation are challenging. Most are fuzzy problems, often difficult to delineate and even harder to represent in a way that makes them solvable. In addition, inverse problems imply a novelty for each case, and expertise should reflect an ability to react to situations that experts have never encountered before. In this context, problems cannot be solved 'automatically' or

only ‘intuitively.’ [Until a hyper-reality is comprehended, organized, and verbalized, ill-defined/inverse problems must rely, at least partically, on intuition to find a remedy.]

The Dreyfus model has been derived from observation of the performance of experts, such as jet pilots and dancers, experts who are used to tackling direct problems. Is it correct to use this model also to explain the performances of experts who are used to tackling inverse problems? It is plausible that often the skills involved in solving direct problems are not the same as those involved in solving inverse problems. Think about the skills needed to solve this short list of inverse problems: to ‘guess’ the intention of a person from his/her behavior, to discover the authors of a crime knowing the crime scene, to ‘imagine’ an internal body part from the attenuation in intensity of an X-ray beam, to guess the premises of an argument from some of its conclusions, or to diagnose a sickness on the strength of its symptoms. The investigation of those problems does not proceed downstream, from premises to conclusions or from causes to effects. Working on all those problems involves reversing the logical or causal stream. In medicine, physicians face inverse problems all of the time. In fact, the typical diagnosis problem is not the direct problem of inferring syndrome from disease, but the inverse problem of guessing disease from symptoms. Anyone who wants to propose a model to explain how we develop clinical problem-solving skills must recognize carefully that the skills used to solve inverse problems are of a different nature than the skills used to solve direct problems. A model should be specific for skills of different natures; the Dreyfus model is not specific enough.

Rules and Context

In the Dreyfus model, a novice should memorize rules and should not feel responsible for other things: ‘to improve, the novice needs monitoring, either by self-observation or instructional feedback, so as to bring his behavior more and more completely into conformity with the rule.’ Besides, the Dreyfus model supports the idea that at proficient and competent levels, performers should have developed ‘personal guidelines and maxims’ in order to be able to deal successfully with tasks and problems. [Developing maxims is beyond mere proficiency and competence. High level of mastery is required at this level.] Why do we have to assume that these Dreyfus propositions are right? Is that the way we learn skills of explicit or even of tacit nature? Is it a good idea to memorize rules at novice stages? Do proficient and competent physicians solve diagnostic problems using just a set of ‘personal’ rules and maxims?

Early problem-solving research proposed the ‘general problem solver model.’ In this model the solution of a problem is conceptualized as a movement between two states: a starting state, named ‘problem space,’ and a final state named ‘goal state.’ There are ‘rules of transition’ which refer to those functions that move the system from one state to another, and there are also heuristics tools, rules that determine which moves are to be made in the problem space. Although this model gives great value to the use of rules, it should be recognized that these

components are well suited for solving well-defined and direct problems, where the space and transitions between states are unambiguous. However, the model offers no solution whatsoever for dealing with inverse problems, for which there do not exist simple rules to solve them. [There is an imaginative "ideal" and the world of reality. The "ideal" is a model for teaching; while hypothetical challenges can be created to train students based on analogies and triangulation rooted in real-world experiences.]

In medicine, although there are clinical guidelines and algorithms available that can help physicians deal with some problems, physicians acknowledge that these 'rules' are just general recommendations. Besides, physicians use 'guidelines' after they have transformed an inverse problem into a direct one. This is after diagnostic hypotheses have been generated. However, there is not a recipe to generate hypotheses. Furthermore, physicians use heuristic rules, such as Occam's razor regarding frugality, but these 'rules' are general recommendations. They are explicit (not personal), and still it is not well known what impact they have on clinical problem solving skills.

Rules are instructions for doing something, and even when they may be constructed as a mapping of possible actions (algorithms), they do not describe or explain any particular event or thing because they prescribe what to do. If we accept that knowledge has a transferable content that has been encoded and externalized in cultural artifacts, such as a book, then we should recognize that rules are not the sole element of that content, because knowledge consists of thousands of concepts, propositions, and theories. This knowledge allows us to grasp the nature of disease; understanding is a pre-requisite to learning. The development of clinical reasoning skills for medical students is dependent on basic science achievements. Novices, who rely on biomedical knowledge, solve complicated diagnostic problems with more success.

Believing that students should only memorize rules has a dark side and can cause deleterious consequences. When rules are available for everything, novices can spare the effort of imagining a different way to solve an inverse problem. Hence, they would tend to proceed to solve problems in a rather mindless way. We should reflect on the fact that to learn, students need all kinds of stimuli, such as propositional from books and experience. But they also need freedom to develop the talent to produce diagnostic hypotheses by spotting, inventing, and sometimes guessing.

Other elements to analyze are Dreyfus ideas that learners at pre-competent stages have a complete ignorance of the 'context,' and that the education at this level should be decontextualized: 'normally, the instruction process begins by decomposing the task environment into context-free features which the beginner can recognize without benefit of experience.' Contrary to such an idea, we should acknowledge that everything in our world, including concepts, is interrelated. Learning, as any other event, happens under specific conditions and should not be

detached from the real experience. Medical students always face the context. Of course, at the beginning, there is not enough insight into every detail. However, students' minds are not like computers following a program; they have some ideas, some approaches, and some knowledge of the context. For example, medical students can generate numerous diagnostic inferences, even without considerable clinical experience. How can they do that if novices like them 'ignore' the context? Accumulating experience is not a passive recording. Learning is creative in the sense that it is new and not automatic to the individual. Even at the pre-beginner stage, learners gain experience and understanding of the context. Information, context, and experience cannot be separated.

Intuition

The Dreyfus brothers propose that intuition is the endpoint of learning and a key characteristic of expertise: 'the expert pilot, having finally reached this non-analytical stage of performance, responds intuitively and appropriately to his current situation.' [Wouldn't it be more appropriate to refer to the cognitive process Dreyfus analyzes as *habitually* rather than *intuitively*? Intuition in such processing can play an important role, but Dreyfus appears to expand its meaning beyond its boundaries. There are a number of cognitive processes taking place in all of Dreyfus' examples – intuition being one of them but not the only one.] Hubert Dreyfus describes a master as one with a lot of experience who produces almost instantaneously appropriate perspectives, who thinks intuitively, not analytically, and who ceases to pay conscious attention to his performance turning it unconsciously: 'the expert, like masters in the ''long Zen tradition'' or Luke Skywalker when responding to Obi Wan Kenobi's advice to use the force ''transcends'' ''trying'' or ''efforting'' and ''just responds.''' [True for some cognitively processing, but certainly not for all.]

Adults often learn to drive a car, type, play chess, ski, etc. In most cases we perform such skills intuitively, quickly, unconsciously, and 'just respond.' [Except for chess, these are good examples of *habituation* first, and perhaps *intuition* second. Chess is an example where *intuition* and *reason* are used simultaneously. *Habituation* is more of a *reflexive* response – analogous to an *instinctive* response – which probably does not apply to chess. Dreyfus is attempting to join *habituation* and *reflexive* responses – and perhaps even *reasoning's* contributions – under the one heading of *intuition* in order to simplify an explanation for mastery of some cognitive abilities. However, it is good that *intuition's* part in cognitive activities is being analyzed to such depth since public education programs appear to completely ignore its relevance in their race for superior test scores based on memorization.] These everyday skills are relatively easy to acquire, at least to an acceptable level. It is plausible that some steps required to perform a simple task are so fast that we consider them on an unconscious level even though we are alert and oriented.

[Also consider that synonyms offered by Thesaurus.com – such as innate, perceptive, visceral, habitual, inherent, instinctual, involuntary, natural,

understood, untaught, etc. – provide perspectives of how to best understand the meaning of *intuition*. Therefore, intuition is not necessarily the result of education as Dreyfus postulates. In his *The Empire of Business* (1902), Andrew Carnegie proposes that too much education dampens intuition and reasoning abilities (due to its effects on molding the mind in the academic realm rather than the real world) which are requisite to be a highly successful entrepreneur. For his day, he proposed that 8tth grade be the end of a formal education if one wished to succeed in business. However, he stated that if one continued on with formal education, then that person can be successful working for an entrepreneur.]

Implications and Conclusions

… Although the Dreyfus model is not taken strictly as a 'prescription,' it is plausible that its descriptive face is influencing us to generate a worldview, a general outlook of how we learn and teach medicine. Every worldview has an effect on our actions and policies. And here is the point of major implication, because this model can influence educative policies, recommendations, and guidelines. This model can also generate unhappy contradictions. For example, it has been said that the Dreyfus model provides us with a framework for consistency within the evaluation system. How can this model help us to ground our evaluation system if the model suggests explaining physicians' performance in terms of implicit knowledge and intuition? By definition, if implicit knowledge is not expressible in some language, then it is inaccessible to evaluate [other than through a real-world demonstration of an action. In medicine, case studies can provide such evaluations where the student is required to provide a diagnosis and prescription for cases presented to them.] Certainly, we need more debates and we need to evaluate this model not only in light of philosophical but also of scientific considerations.

Although the Dreyfus model could partially explain the 'acquisition' of some skills, it is another matter as to whether it can explain the acquisition of clinical skills. The occurrence of inverse problems and the rich interplay between the implicit and explicit domains of knowledge must be taken into consideration when we want to explain 'acquisition' of clinical skills. The idea that the net effect of education and training in medicine is that we start developing intuition about what we are doing must be revised and evaluated carefully.

Using this model in a prescriptive way must elicit a more critical eye to see if novices must receive an education where rules are the only important things to learn in a decontextualized environment. Finally, we must acknowledge the complexity of all the processes implied in learning. We cannot merely accept the temptation to oversimplify these complex processes [which it appears Dreyfus has done], and ignore intentionally or not information from science, in particular from cognition, psychology, and neuroscience.

Analysis of medical education offers realistic methodology and structural goals for career-oriented education. Career education requires a knowledge base of axioms, rules,

facts, and experiences in order to build the mental and physical structures for mastery of an occupation where intuitiveness can come into play.

In contrast, a Classical Education lays a foundation for developing reasoning abilities that envelops ones' entire life experience; the majority of which should be accomplished prior to occupational training, but with continued reference to Classical *reasoning* throughout the educational experience in order to reinforce this ability, which will eventually grow into what we call *wisdom*, which incorporates *intuition* in its arsenal.

Conclusion

Francis Bacon (1561-1626) introduces the reader to his work by starting off with first impressions and how these steer individuals and society thereafter.

> Being convinced, by a careful observation, that the human understanding perplexes itself, or makes not a sober and advantageous use of the real helps within its reach, when manifold ignorance and inconveniences arise, he was determined to employ his utmost endeavors toward restoring or cultivating a just and legitimate familiarity between the mind and things.
>
> But as the mind, hastily and without choice, imbibes and treasures up the first notices of things, from whence all the rest proceed, errors must forever prevail, and remain uncorrected, either by the natural powers of the understanding or the assistance of logic; for the original notions being vitiated, confused, and inconsiderately taken from things, and the secondary ones formed no less rashly, human knowledge itself, the thing employed in all our researches, is not well put together nor justly formed, but resembles a magnificent structure that has no foundation. (p. 9)

Such is the weakness of the human mind, which is a major barrier to transfer. If the mind's perception of the real world has serious flaws due to chance encounters that establish first and enduring impressions, the transfer process within the mind has numerous obstacles to surmount. We see this play out in every sector of society, regardless of educational attainment or position within a community. Even those with the greatest amount of education fall prey to the flaws they developed in their past; and, ironically, in some cases, they have been led astray by the very education that was supposed to correct flawed views. This is most apparent in the social sciences where science and statist political philosophy have become so intermingled, cause and effect become indiscernible and irrational.

It is the responsibility of an educational program to assist students in acquiring reasoning abilities to discern falsehoods and illusions – rather than stuff the brain full of data – that surround all of us. Natural Law philosophers of the Enlightenment were keen on such discernment. Their works, available through Liberty Fund, can be of tremendous

assistance in education. In addition, heuristics[50] can aid in this effort since it is how individuals actually attempt to resolve problems encountered in the real world, as compared to utilizing the scientific method, to find answers to life's challenges.

It is also important to teach students what is comprehensible by the human mind and what is not.[51] What is comprehensible is a motivating challenge for mankind; what is not must be left to a philosophical or theological analysis.

To teach for transfer means to provide a multitude of lessons through applications that provide excellent examples of real-world issues. But to build deep and broad understanding of phenomena, axioms must be laid as the foundation for full comprehension to take place. From this, trouble-shooting and innovation become manifest. Without axioms, man makes mistakes and stumbles around (i.e., employing the process of elimination) which coincidentally leads him to correct conclusions.

Jordan Peterson, a true scientist, sets a good example for education to strive for in that he always operates within fundamental principles when seeking answers to truths. Currently, educators work in a world guided primarily by the senses, with little understanding of axioms, first principles, root causes, fundamentals, etc., and focus primarily on facts, material things, or simple tools that help navigate within the fleeting world – think of mathematical computation used to this end. However, the change that occurs is grounded in unchanging first principles, but since academia is largely ignorant of first principles, many even in denial of them, they operate primarily in the unpredictable and erratic material realm. Without an understanding of first principles, the world appears disordered and chaotic, and therefore, everything appears relative.

Rather than curricula focusing on facts, the material world, and the simple tools, we need to incorporate first principles and then use the facts, material world, and simple tools as analogies to get the points across. Think of it this way: If the material world is constantly changing, why teach something as though it's extremely important when in actuality, it is fleeting? It's not unlike computer science: What experts knew in the 80s is antiquated compared to what computer scientists need to know today. What was known has "fled" and what is known is fleeting. Why do we force students to embrace the fleeting while ignoring that which the universe is built upon and does not change?

Understanding first principles allows us to have a far better understanding of the transformations and variables that are in constant flux. For example, H^2O has the potential of going through 3 different states: solid, liquid and gas. If one were ignorant of the three states and had never observed such transformations and then suddenly observes the changes, he would be baffled by what he is perceiving. The change would be

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[50] Involving or serving as an aid to learning, discovery, or problem-solving by experimental and especially trial-and-error methods <*heuristic* techniques> <a *heuristic* assumption>; *also* **:** of or relating to exploratory problem-solving techniques that utilize self-educating techniques (as the evaluation of feedback) to improve performance <a *heuristic* computer program> https://www.merriam-webster.com/dictionary/heuristic

[51] Try to define what "love" means; try to explain why we appreciate music; what is intuition?; etc.

frightening to him since he may think water (all water) may have gone through the same transformation, and will no longer be there for him to drink.

People are, more often than not, frightened by that which they do not understand. First principles allow people to better understand change, which will provide comfort and security and the ability to move forward in their lives unintimidated by the changes. As Peterson would put it, people could then ignore most phenomena in order to focus on the goals they set for themselves in a given period of time. Humans are incapable of constantly paying attention to all phenomena that surrounds them, but must subconsciously be highly selective in what they do pay attention to so as not to overtax their minds with useless or irrelevant things. Focusing on something takes a lot of brain power and the brain prefers being habituated to activities rather than having to constantly analyze them.

To help better understand Peterson's pursuit of first principles, let's consider Henry de Bracton (c. 1210-c. 1268, renowned British jurist) who contemplated three truths or laws to better explain differences between subjective and objective truths. He explained there are universal, human, and transitory laws. Universal laws are true in all places, under all circumstances, and for all time. Human laws are true in all places, under all circumstances, and for all time, as it relates to humans. Transitory laws (such as many civil laws) are dependent on time and place and shift with changing times and in different locales. The former two are objective laws, while the latter is a subjective law.

An example of Bracton's transitory law principle applied in civil law might be traffic laws and regulations related to which side of the road a society drives on. In Britain, it's on the left side, while in America, it's on the right side. Neither choice is superior to the other so there is no fundamental law in play in this regard. However, once a society has decided, then everyone must comply with the decision. Which side of the road a society chooses makes it relative, but that everyone comply with the choice makes it objective and universal in that society.

An example that may get the point across of Bracton's *human laws* is the use of precedent (*stare decisis*) in legal decision making, which Bracton played a hand in developing. In the Wikipedia page dedicated to Bracton, the author provides: "A single unique decision did not make precedent. Custom began to be dictated when several cases of similar fact-pattern were decided by different courts in the same way. This was the beginning of *stare decisis*."[52]

This is a similar principle that is observed in the use of *meta-analysis*. The Free Dictionary offers this explanation of meta-analysis: "A method that uses statistical techniques to combine results from different studies and obtain a quantitative estimate of the overall effect of a particular intervention or variable on a defined outcome – i.e., it is a statistical process for pooling data from many clinical trials to glean a clear answer. Meta-analysis produces a stronger conclusion than can be provided by any individual

[52] https://en.wikipedia.org/wiki/Henry_de_Bracton

study." Therefore, meta-analysis is analyzing underlying facts that lead to a better understanding of a truth.

Both in law and scientific investigation, a fundamental principle can be discovered from multiple phenomena of a similar nature. It is difficult to discover truths from single incidents, but by observing related incidents and phenomena over time, truths can be either more easily approached, or possibly even discovered.

Jordan, as well as Bracton, sought to differentiate universal truths from transitory truths, which is what should be taught in the educational environment in connection with the transitory phenomena that provides the contexts and analogies of universal truths. With an understanding of first principles, the transfer of learning at all three levels – close, medium and far transfer – is improved dramatically.

A final thought to leave the reader with: *Knowledge does not equal understanding*. An unconventional bicycle makes this evident when it was configured by a welder with two gears between the handle bars and front tire. This reversed the tire's response to the handle bar's steering. Everyone who attempted to ride this bike experienced immediate and utter failure; though Destin (?), the engineer who made the video (The Backwards Brain Bicycle *Smarter Every Day*) and his 5-year-old son, managed success after extensive practice – 8 months for Destin and 2 weeks for his son. Equally fascinating was Destin's attempt to ride a normal bike afterward and his lack of success until after twenty minutes of practice, his brain "clicked" back in and he was able to ride it again.

An experiment such as this demonstrates that though we may think we know something, it doesn't always translate into actionable understanding. This is why "book learning" or abstract knowledge, doesn't mean a person understands the knowledge sufficiently to apply it in the real world, hence the reason apprenticeships are so important. It takes time for the brain to adapt and configure itself to the demand an action requires – and everyone is different. This is why academic oriented "intelligence" tests that are always designed with time as an element of what's being measured, is a useless and harmful component of tests.

Another lesson from this video is the difference in time it took Destin's brain versus his son's to reconfigure their understanding to ride the unconventional bike. It demonstrates Piaget's stages of development theory has merit.

Watch the video to learn more about the concept that *knowledge does not equal understanding*: https://www.youtube.com/watch?v=MFzDaBzBlL0

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