**Session 8 : A Liberal Education**

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What is education? Above all things, what is our ideal of a **thoroughly**() liberal education?

of the education which, if we could **mold()** the fates to our own will, we would give our children?

Well, I know not what may be your **conceptions()** upon this matter but I will tell you mine, and I hope I shall find that our views are not very **discrepant()**.

Dont you think we should all consider it to be a primary duty to learn at least the names and the moves of the pieces; to have a notion of a gambit, and a **keen()** eye for all the means of giving and getting out of check?

Do you not think that we should look with a **disapprobation()** amounting to scorn upon the father who allowed his son, or the state which allowed its members, to grow up without knowing a pawn from a knight?

Yet, it is a plain and **elementary()** truth that the life, the fortune, and the happiness of every one of us, and more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess.

The player on the other side is hidden from us. We know that his play is always fair, **just**, and patient.

But also we know, to our cost, that he never overlooks a mistake, or **makes the smallest allowance for()** ignorance.

To the man who plays well, the highest stakes are paid, with that sort of overflowing generosity in strength. And one who plays ill is checkmated without **haste()**, but without **remorse()**.

My metaphor will **remind** some **of** you the famous picture in which Retzsch has **depicted()** Satan playing at chess with man for his soul.

**Substitute for()** the **mocking fiend** in that picture a calm, strong angel who is playing for love, as we say, and would rather lose than win and I should accept it as an image of human life.

In other words, education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the **fashioning()** of the affections and of the will into an earnest and loving desire to move in harmony with those laws.

Anything which **professes()** to call itself education must be tried by this standard, and if it fails to stand the test, I will not call it education, whatever may be the force of authority or of numbers upon the other side.

Take an extreme case. Suppose that an adult man, in the full vigor of his **faculties()**, could be suddenly born in the world, as Adam is said to have been, and then left to do as he best might.

Nature would begin to teach him, through the eye, the ear, the touch, the properties of objects. Pain and pleasure would be at his **elbow()** telling him to do this and avoid that;

And if to this **solitary()** man entered a second Adam, or better still, an Eve, a new and greater world, that of social and moral phenomena, would be revealed.

Joys and **woes()**, compared with which all others might seem but **faint()** shadows, would **spring()** from the new relations.

Happiness and sorrow would take the place of the **coarse() monitors**, pleasure and pain;

And then, long before we **were susceptible of()** any other mode of instruction, nature took us in hand, and every minute of waking life brought its educational influence, shaping our actions into **rough accordance with()** natures laws, so that we might not be ended untimely by too **gross()** disobedience.

The great mass of mankind are the Poll, who pick up just enough to get through without much **discredit()**.

Natures pluck means **extermination()**.

Thus the question of **compulsory education()** is settled so far as nature is concerned.

Her bill on that question was **framed()** and passed long ago.

But, like all compulsory legislation, that of nature is **harsh()** and **wasteful()** in its operation.

Ignorance is **visited** as sharply as **willful** disobedience incapacity meets with the same punishment as crime.

Natures **discipline** is not even a word and a blow, and the blow first; but the blow without the word.

The object of what we commonly call education that education in which man **intervenes()** and which I shall distinguish as artificial education is to make good these defects() in natures methods;

And a liberal education has not only prepared a man to escape the great evils of disobedience to natural laws, but has trained him to appreciate and to seize upon the rewards which nature **scatters()** with as free a hand as her penalties.

That man, I think, has had a liberal education who has been so trained in youth that his body is the **ready()** servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of;

one who, no stunted ascetic, is full of life and fire, but whose passions are trained to **come to heel()** by a vigorous will, the servant of a tender conscience;

He will make the best of her, and she of him. They will get on together rarely; she as his ever **beneficent()** mother; he as her **mouthpiece()**, her conscious self, her minister and interpreter.

**Session 7 : Hidden Intellectualism()**

What doesnt occur to() us, though, is that schools and colleges might be at fault() for missing the opportunity to tap into() such street smarts andchannel() them into good academic work.

We assume that its possible to wax() intellectual about Plato, Shakespeare, the French Revolution, and nuclear fission, but not about cars, dating, fashion, sports, TV, or video games.

Real intellectuals turn any subject, however lightweight it may seem, into grist for their mill through the thoughtful questions they bring to it, whereas a dullard() will find a way to drain() the interest out of the richest subject. Thats why a George Orwell writing on the cultural meanings of penny postcards is infinitely more substantial() than the cogitations() of many professors on Shakespeare or globalization.

I offer my own adolescent() experience as a case in point(). Until I entered college, I hated books and cared only for sports.

The only reading I cared to do or could do was sports magazines, on which I became hooked().

In the Chicago neighborhood I grew up in, which had become a melting pot() after World War II, our block was solidly() middle class, but just a block awaydoubtless concentrated there by the real estate companieswere African Americans, Native Americans, and hillbilly whites who had recently fled postwar joblessness in the South and Appalachia.

Negotiating() this class boundary was a tricky matter. On the one hand, it was neces- sary to maintain the boundary between clean-cut boys like me and working-class hoods, as we called them, which meant that it was good to be openly smart in a bookish sort of way.

On the other hand, I was desperate for() the approval of the hoods, whom I encountered daily on the playing field and in the neighborhood, and for this purpose it was not at all good to be book-smart.

The hoods would turn on() you if they sensed you were putting on airs() over them: Who you lookin at, smart ass? as a leather-jacketed youth once said to me as he relieved me of my pocket change along with my self-respect.

I grew up torn, then, between the need to prove I was smart and the fear of a beating if I proved it too well; between the need not to jeopardize() my respectable future and the need to impress the hoods. As I lived() it, the conflict came down to() a choice between being physically tough and being verbal().

For a boy in my neighborhood and elementary school, only being tough earned you complete legitimacy().

I still recall endless, complicated debates in this period with my closest pals over who was the toughest guy in the school. If you were less than negligible() as a fighter, as I was, you settled for() the next best thing, which was to be inarticulate(), carefully hiding telltale() marks of literacy() like correct grammar and pronunciation.

Yet in retrospect, I see that its more complicated, that I and the 1950s themselves were not simply hostile toward intellectualism, but divided() and ambivalent().

When Marilyn Monroe married the playwright Arthur Miller in 1956 after divorcing the retired baseball star Joe DiMaggio, the symbolic triumph() of geek() over jock() suggested the way the wind was blowing.

Even Elvis, according to his biographer Peter Guralnick, turns out to have supported Adlai over Ike in the presidential election of 1956. I dont dig() the intellectual bit(), he told reporters. But Im telling you, man, he knows the most.

Though I too thought I did not dig the intellectual bit, I see now that I was unwittingly() in training for it.

I see now that in the interminable analysis of sports teams, movies, and toughness that my friends and I engaged ina type of analysis, needless to say, that the real toughs would never have stooped to()I was already betraying an allegiance() to the egghead world.

Only much later did it dawn on() me that the sports world was more compelling() than school because it was more intellectual than school, not less. Sports after all was full of challenging argu- ments, debates, problems for analysis, and intricate() statistics that you could care about, as school conspicuously() was not.

Sports introduced you not only to a culture steeped in() argument, but to a public argument culture that transcended the personal.

I cant blame my schools for failing to make intel- lectual culture resemble() the Super Bowl, but I do fault(vt. ) them for failing to learn anything from the sports and entertainment worlds about how to organize and represent intellectual culture, how to exploit its gamelike element and turn it into arresting() public spectacle() that might have competed more successfully for my youthful attention.

For here is another thing that never dawned on me and is still kept hidden from students, with tragic() results: that the real intellectual world, the one that existed in the big world beyond school, is organized very much like the world of team sports, with rival texts, rival interpretations and evaluations of texts, rival theories of why they should be read and taught, and elaborate() team competitions in which fans of writers, intellectual systems, methodologies, and -isms contend() against each other.

To be sure, school contained plenty of competition, which became more invidious() as one moved up the ladder (and has become even more so today with the advent() of high-stakes testing). In this competition, points were scored not by mak- ing arguments, but by a show of information or vast reading, by grade-grubbing, or other forms of one-upmanship(). School competition, in short, reproduced the less attractive features of sports culture without those that create close bonds and community.

And in distancing themselves from anything as enjoyable 15 and absorbing as sports, my schools missed the opportunity to capitalize on() an element of drama and conflict that the intel- lectual world shares with sports. Consequently, I failed to see the parallels() between the sports and academic worlds that could have helped me cross more readily from one argument culture to the other.

But if this argument suggests why it is a good idea to assign readings and topics that are close to students existing interests, it also suggests the limits of this tactic().

Making students nonacademic interests an object of academic study is useful, then, for getting students attention and overcoming their boredom and alienation(), but this tactic wont in itself necessarily move them closer to an academically rigorous() treatment of those interests.

On the other hand, inviting students to write about cars, sports, or clothing fashions does not have to be a pedagogical cop-out() as long as students are required to see these interests through academic eyes, that is, to think and write about cars, sports, and fashions in a reflective, analytical way, one that sees them as microcosms of what is going on in the wider culture.

If I am right, then schools and colleges are missing an opportunity when they do not encourage students to take their nonacademic interests as objects of academic study. It is self-defeating to decline to introduce any text or subject that figures() to engage() students who will otherwise tune out() academic work entirely. If a student cannot get interested in Mills On Liberty but will read Sports Illustrated or Vogue or the hip-hop magazine Source with absorption, this is a strong argument for assigning the magazines over the classic.

Give me the student anytime who writes a sharply argued, sociologically acute() analysis of an issue in Source over the student who writes a lifeless explication() of Hamlet or Socrates Apology.

**Session 6 : Four Laws of Ecology**

Each species is suited to its particular environmental niche(), and each, through its life processes, affects the physical and chemical properties() of its immediate environment.

These links are bewildering() in their variety and marvelous in their intricate detail.

Ecology has not yet explicitly() developed the kind of cohesive(), simplifying generalizations() exemplified by, say, the laws of physics.

We owe the basic concept, and the word itself, to the inventive() mind of the late Norbert Wiener.

The word cybernetics derives() from the Greek word for helmsman; it is concerned with cycles of events that steer(), or govern, the behavior of a system.

If the ship veers() off the chosen compass course, the change shows up in the movement of the compass needle.

This depletes() the supply of inorganic nutrients so that two sectors of the cycle, algae and nutrients, are out of balance, but in opposite directions.

If the nutrient level of the water becomes so high as to stimulate the rapid growth of algae, the dense algal population cannot be long sustained because of the intrinsic() limitations of photosynthetic efficiency.

The dynamic behavior of a cybernetic systemfor example, the frequency of its natural oscillations, the speed with which it responds to external changes, and its over-all rate of operationdepends on the relative rates of its constituent() steps.

The metabolic rates of these organismsthat is, the rates at which they use nutrients, consume oxygen, or produce wasteis inversely() related to their size.

Suppose that the rate at which organic waste enters the cycle is increased artificially(), for example, by dumping sewage() into the water.

Thus, an acre of richly populated() marine shoreline or an acre of fish pond produces about seven times as much organic material as an acre of alfalfa annually.

The feedback characteristics of ecosystems result in amplification() and intensification() processes of considerable magnitude().

A persistent() effort to answer the question Where does it go? can yield() a surprising amount of valuable information about an ecosystem.

Here the mercury is heated; this produces mercury() vapor which is emitted by the incinerator stack, and mercury vapor is toxic().

It is also an excellent way to counteract() the prevalent() notion that something which is regarded as useless simply goes away when it is discarded.

**Session 5 : ILLINOIS JOURNEY**

The roads are wide, hard, perfect, sometimes of a shallow depth in the far distance but so nearly level() as to make you feel that the earth really is flat.

Giant skies, giant clouds, an eternal nearly featureless sameness.

Miles and miles of prairie(), slowly rising and falling, sometimes give you a sense that something is in the process of becoming, or that the liberation of a great force is imminent(), some power, like Michelangelo's slave only half released from the block of stone.

Conceivably() the mound-building Indians believed their resurrection would coincide with() some such liberation, and built their graves in imitation of the low moraines deposited by the departing glaciers.

After spring plowing(plough) it looks oil-blackened or colored by the soft coal which occurs in great veins throughout the state.

Along the roads, with intervals() between them as neat and even as buttons on the cuff, sit steel storage bins, in form like the tents of Mongolia.

And the elevators and tanks, trucks and machines that crawl() over the fields and blunder() over the highways -- whatever you see is productive. It creates wealth, it stores wealth, it is wealth.

As you pass the fields, you see signs the farmers have posted() telling in short code what sort of seed they have planted.

Then, when you have gone ten or twenty miles through cornfields without having seen a living thing, no cow, no dog, scarcely even a bird under the hot sky, suddenly you come upon a noisy contraption at the roadside, a system of contraptions, rather, for husking the corn and stripping() the grain. It burns and bangs away, and the conveyor belts rattle()...

When you force your mind to summon() them, the Indians appear rather doll-like in the radiance of the present moment.

There are monuments to them...throughout the state, but they are only historical ornaments() to the pride of the present...

# Session 3 : Growing Brighter

But step in, through a large airlock designed to keep out the bugs, and a kaleidoscopic() scene emerges.

A central aisle is flanked() by two pairs of towers.

Each tower is stacked with() a dozen or so trays on which are growing strawberries, kale, red lettuce and coriander.

Douglas Elder, who is in charge of this artificial Eden, taps() some instructions into an app on his mobile phone and, with a short whirrof machinery, a tray of lush, green basil slides() out for his inspection().

The app can also control the temperature, humidity() and ventilation(), and the hydroponic system that supplies the plants, growing on various non-soil substrates, with water and nutrients.

Armed with his trusty phone, Mr. Elder says he can run the farm almost single-handedly.

But the business is now taking off(). SoftBank, a Japanese firm, Googles former boss Eric Schmidt and Amazons founder Jeff Bezos have between them ploughed() more than $200m into Plenty, a vertical-farming company based in San Francisco.

And in June Ocado, a British online grocery, splashed out() 17m ($21.3m) on vertical-farming businesses to grow fresh produce within its automated distribution depots.

The high-tech LEDs in IGSs demonstration unit are optimized() so that naryphoton is wasted. The hydroponics, and the recycling that supports them, mean the only water lost from the system is that which ends up as part of one of the plants themselves.

And towers mean the system is modular(), and so can be scaled up(=stack).

And modern greenhouses can also use solar-powered supplementary() LED lighting to extend their growing seasons and hydroponic systems to save water, says Viraji Puri, co-founder.

This has meant that production has been commercially viable() for high-value, perishable() produce only, such as salad leaves and herbs.

That, nevertheless, is a market not to be sniffed at().

Plants are green because their leaves contain chlorophyll, a pigment that reflects the green light in the middle of the spectrum() while absorbing and using for photosynthesis() the blue and red wavelengths at either end of it.

It uses LEDs that are highly tuneable().

This, says Mr. Farquhar, can cut energy costs to about half of those incurred() by existing vertical farms.

This, the company claims, is between two and three times more than a conventional() greenhouse with an equivalent but horizontal growing area, and equipped with supplementary lighting and heating, could manage.

Another is to develop algorithms to control, in an equally bespoke() way, the climatic() conditions preferred by different crops.

All the processes involved are engineered() to be efficient.

Bulk field crops, such as wheat and rice, may never make sense for a vertical farm, and larger, heavier vegetables would be tricky() to raise.

In the controlled environment of a vertical farm, from which both pests and diseases can be excluded(), seed potatoes could be propagated() more efficiently than in the big, bad outdoor world.

The institutes researchers are also looking at plant varieties that might do particularly well indoors, including old varieties passed over in the search for crops which can withstand() the rigors() of intensive farming systems.

By dipping into() the institutes gene banks, Dr Campbell thinks it may find some long-forgotten fruits and vegetables that would thrive() in the security of a vertical farm.

Shoppers might even find some exotic() varieties growing in supermarket aisles.

Herbs and salad leaves, including exotics() such as Genovese basil and Peruvian mint, are resupplied with seedlings from the companys nursery as the mature plants are picked.

Vertical farming then will not feed the world, but it will help provide more fresh produce() to more people.

It may even be that, as vertical-farming systems improve further, miniature() versions will be designed for people to put in their kitchens.